BLUEBACK SALMON
Oncorhynchus nerka
AGE AND LENGTH AT SEAWARD MIGRATION PAST BONNEVILLE DAM

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BLUEBACK SALMON, ONCORHYNCHUS NERKA AGE AND LENGTH AT SEAWARD MIGRATION PAST BONNEVILLE DAM

By

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ABSTRACT

Some downstream-migrant blueback salmon pass Bonneville Dam in each month of the year, but trap catches indicate that the bulk of migration occurs during April and May. Of the bluebacks in this study, 93 percent were yearlings or in their second year. Ages ranged from 1 to 5 years. Length-frequency graphs show no consistent separation of the races of Columbia River bluebacks. More marked bluebacks were caught from spring than from fall releases from Leavenworth and Winthrop hatcheries; the reverse was true of releases from Little White hatchery. Spring releases tend to migrate immediately, but not as a single school. Bluebacks released in the fall tend to migrate the following spring.

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BLUEBACK SALMON, ONCOHYNCHUS NERKA AGE AND LENGTH AT SEAWARD MIGRATION PAST BONNEVILLE DAM

INTRODUCTION

The Columbia River blueback salmon (Onchorhynchus nerka) is a valuable commercial species. One of the best blueback runs in recent years was in 1947, when an estimated 338,000 fish returned to the river to spawn. The commercial catch taken from the river that year was 219, 000 bluebacks, worth $664,000 to the canners. The 1946-53 average annual value was $290,000 (Pacific Fisherman, Yearbook Number, 1954); the 1949 pack was omitted from the average because it included bluebacks that were not native to the Columbia River.

Fluctuations in the number of adults returning to spawn (in 1945 the total run numbered 10,600 fish) and virus infections in the hatcheries (Rucker et al., 1953) in recent years have focused added attention on the management of this resource. The age and length of bluebacks at the time of seaward migration are of general interest and add to the knowledge of the life history. Also, knowledge of the time of migration and of lengths of downstream migrants will be of value when young salmon are guided past dams. The purpose of this report is to provide this information for Columbia River blueback salmon.

Bluebacks spawn principally in streams that flow into lakes. The fry descend to the lakes soon after hatching, and remain there until they migrate to the ocean. The age at which Columbia River bluebacks migrate seaward varies, but most migrate as 2-year-olds or as yearlings. At the present time, Wenatchee and Osoyoos are the principal populations of this species (see fig. 1).

Bonneville Dam, 140 miles above the river's mouth, and below all blueback spawning areas, is well located for obtaining general information on migrant blueback, and in the future the dam may contribute valuable information for conservation and management of the fishery. The Bonneville catch data are not usable at the present time as an index of abundance of returning adults, but should be usable when it is determined how conditions at Bonneville Dam affect the fingerling-trap catches. No tests have been made to determine whether the proportion of downstream migrants caught by the fingerling traps fluctuates during the year, but it is suspected that the efficiency of the traps varies.

The recovery at Bonneville of marked bluebacks released by hatcheries gives a good indication of the time and rate of migration of hatchery releases, if it is assumed that marked and unmarked fish are similar in these respects. The survival of releases is difficult to determine from the Bonneville catches because the fish released in the spring and those released in the fall may be distributed differently with respect to the rest of the population, and because conditions at Bonneville Dam are not constant. These problems are discussed on pages 17 and 33. No attempt is made in this report to compute survival rates of blueback releases, but the number of marked bluebacks caught at Bonneville is listed later in the report.

The following took part in the collection of data for this report: R.L. Bagwell, C.J. Burner, D.R. Craddock, H.A. Hanson, C.C. Jensen, B.A. Lehman, E.M. Maltzeff, L.G. Schedin, L.C. Schlotterbeck, K.G. Weber, R.C. Wilson and P.D. Zimmer. K.H.Mosher assisted in scale reading.

METHODS

Collection of samples

Random samples were taken from the fingerling traps on 5 working days each week, except that in the spring when large numbers of salmonids were migrating downstream it was necessary to tend the traps on weekends.

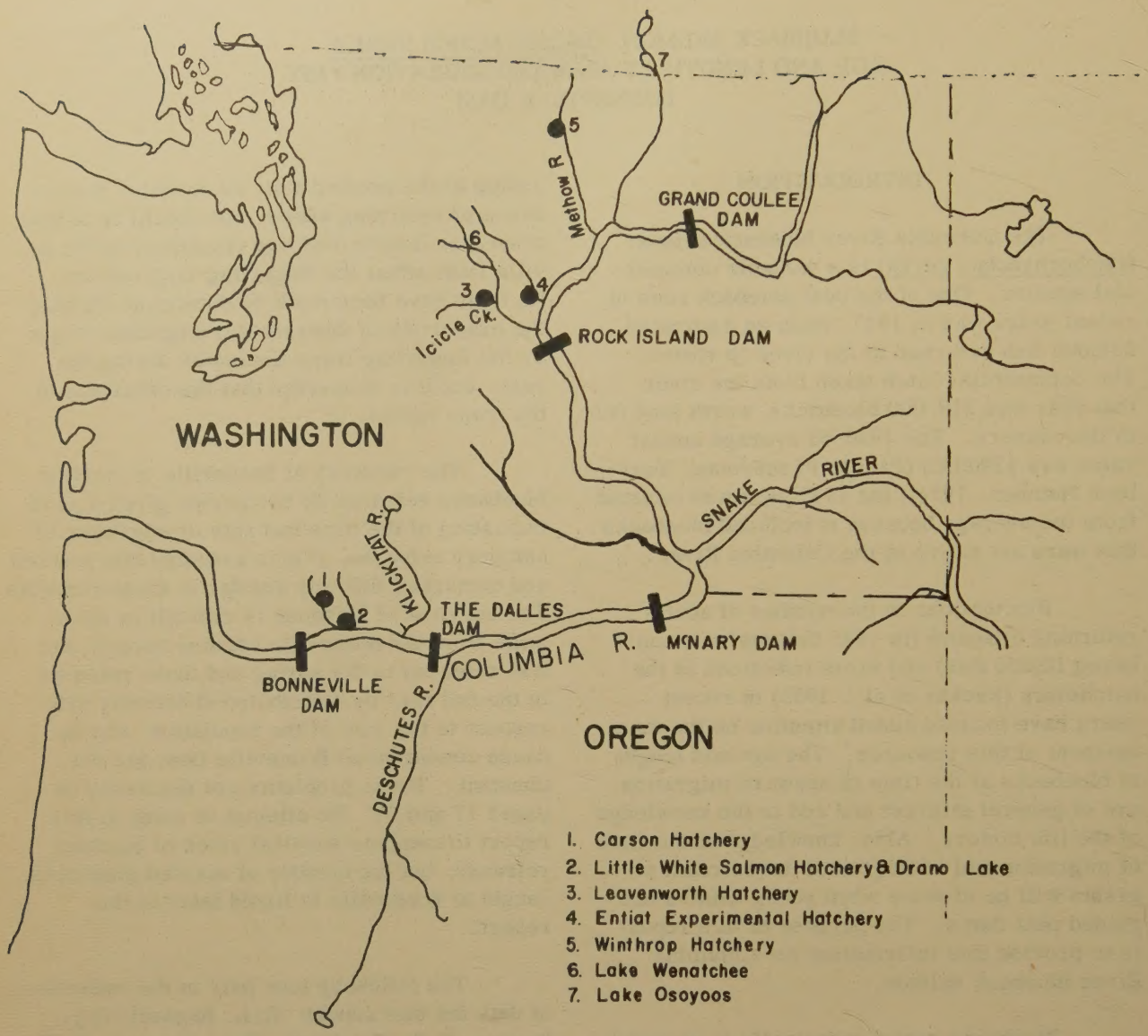


Figure 1.--Location of dams, Federal hatcheries, and bodies of water into which bluebacks have been released by Federal and State agencies.

On some weekends, length measurements and scale samples were taken; on others, the fish were counted and released. After the necessary data were recorded, the sampled fish were released in good condition.

During most of the year it was possible to take length measurements and scale samples from all the bluebacks caught. When large numbers of fish were migrating, a sample usually consisted of all the fish in one of the traps; on occasion it was possible to sample only part of the catch from a single trap. At such times a different trap was picked each day, but no regular rotation was followed. The purpose of this was to avoid bias that might be introduced if size differences existed between the fish caught in different traps.

The daily samples were pooled into 7-day periods, January 1-7 being the first period, January 8-14 the second, and so on (see table 1). This method simplified comparison of the data between years. Most weekly samples contained at least 20 percent of the catch, but during some weeks of heavy migration sample size dropped to as low as 10 percent.

Scales were taken each day, from representative body lengths, from at least 50 percent of the day's sample. Each fish in the scale sample was aged and length-frequency tables by age groups were obtained after the data were pooled into the weekly periods. It was assumed that the fingerling-trap samples accurately depicted the ages and lengths of the total catches. The total catch for each week was computed by direct proportions from 2-mm. length groups of that week's fingerling-trap sample. Sampling between years was not identical because the proportion of the total catch sampled was not constant; no tests were made, but it is believed that the samples give an accurate picture of the trap catches.

Data on time of migration and number of migrants have been collected since 1946. Age and length data have been recorded since 1949.

Age Determination

Scales were used for age determination by counting the number of winter zones (annuli) according to the method perfected for Pacific salmon by Gilbert (1913). The scales were mounted on glass slides in a 4-percent solution of polyvinyl alcohol, and were always taken, if possible, from the left side below the dorsal fin. All scales were aged unless they were regenerated.

Fingerling Traps and Their Location

The Holmes-type inclined-plane fingerling traps[1/], located in the fingerling bypasses of the dam (see fig. 2), were used to collect all samples. The fingerling bypasses provide an escape route for all downstream migrants that enter the auxiliary-water screen pits; however, this number represents only a small fraction of the downstream migrants that pass the dam. A trash sluice that extends across the upstream face of the powerhouse also functions as a fingerling bypass, but it collects only the migrants at the surface of the river. A few migrants pass down the fishways and through the navigation locks. All other downstream migrants pass through the spillway gates or through the turbines.

The purpose of the auxiliary-water screen pits is to provide additional water to the fishways to attract upstream migrants into the fish ladders. The valve-controlled conduits that carry this water are screened to keep out debris and fingerlings. Figure 3 is a diagrammatic drawing of an auxiliary-water screen pit showing the location of the screens and fingerling bypasses.

The fingerling traps are constructed of steel, and can be raised and lowered by hand-operated winches. All water passing through a fingerling bypass is screened by the trap in that bypass. The water is strained through a steel-wire screen that is inclined downward when the trap is operating (fig. 4). A collecting pot

1/Designed by Harlan B. Holmes (Fish and Wildlife Service, 1001 N.E. Lloyd Blvd., Portland, Oregon) and Scott H. Bair (formerly with the Fish and Wildlife Service, and now employed by Chelan County P.U.D. at Wenatchee, Washington)

Table 1--Weekly catch periods.

Week	Dates	Week	Dates	Week	Dates
1	Jan. 1 - 7	18	Apr. 30 - May 6	35	Aug. 27 - Sept. 2
2	Jan. 8 - 14	19	May 7 - 13	36	Sept. 3 - 9
3	Jan. 15 - 21	20	May 14 - 20	37	Sept.10 - 16
4	Jan. 22 - 28	21	May 21 - 27	38	Sept.17 - 23
5	Jan. 29 - Feb. 4	22	May 28 - June 3	39	Sept.24 - 30
6	Feb. 5 - 11	23	June 4 - 10	40	Oct. 1 - 7
7	Feb. 12 - 18	24	June 11 - 17	41	Oct. 8 - 14
8	Feb. 19 - 25	25	June 18 - 24	42	Oct. 15 - 21
9	Feb. 26 - Mar. 4	26	June 25 - July 1	43	Oct. 22 - 28
10	Mar. 5 - 11	27	July 2 - 8	44	Oct. 29 - Nov. 4
11	Mar. 12 - 18	28	July 9 - 15	45	Nov. 5 - 11
12	Mar. 19 - 25	29	July 16 - 22	46	Nov. 12 - 18
13	Mar. 26 - Apr. 1	30	July 23 - 29	47	Nov. 19 - 25
14	Apr. 2 - 8	31	July 30 - Aug. 5	48	Nov. 26 - Dec. 2
15	Apr. 9 - 15	32	Aug. 6 - 12	49	Dec. 3 - 9
16	Apr. 16 - 22	33	Aug. 13 - 19	50	Dec. 10 - 16
17	Apr. 23 - 29	34	Aug. 20 - 26	51	Dec. 17 - 23
				52	Dec. 24 - 31

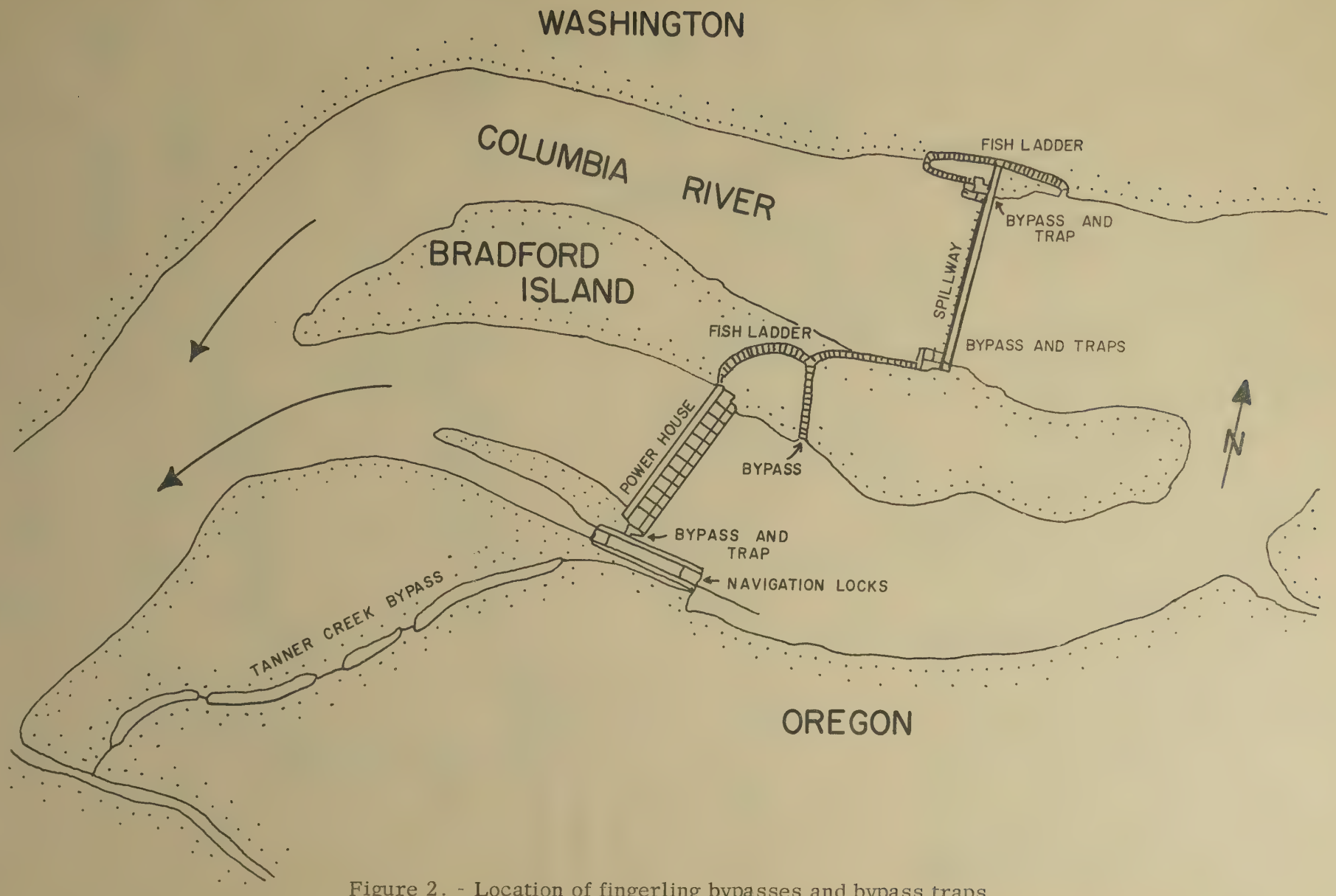


Figure 2. - Location of fingerling bypasses and bypass traps at Bonneville Dam.

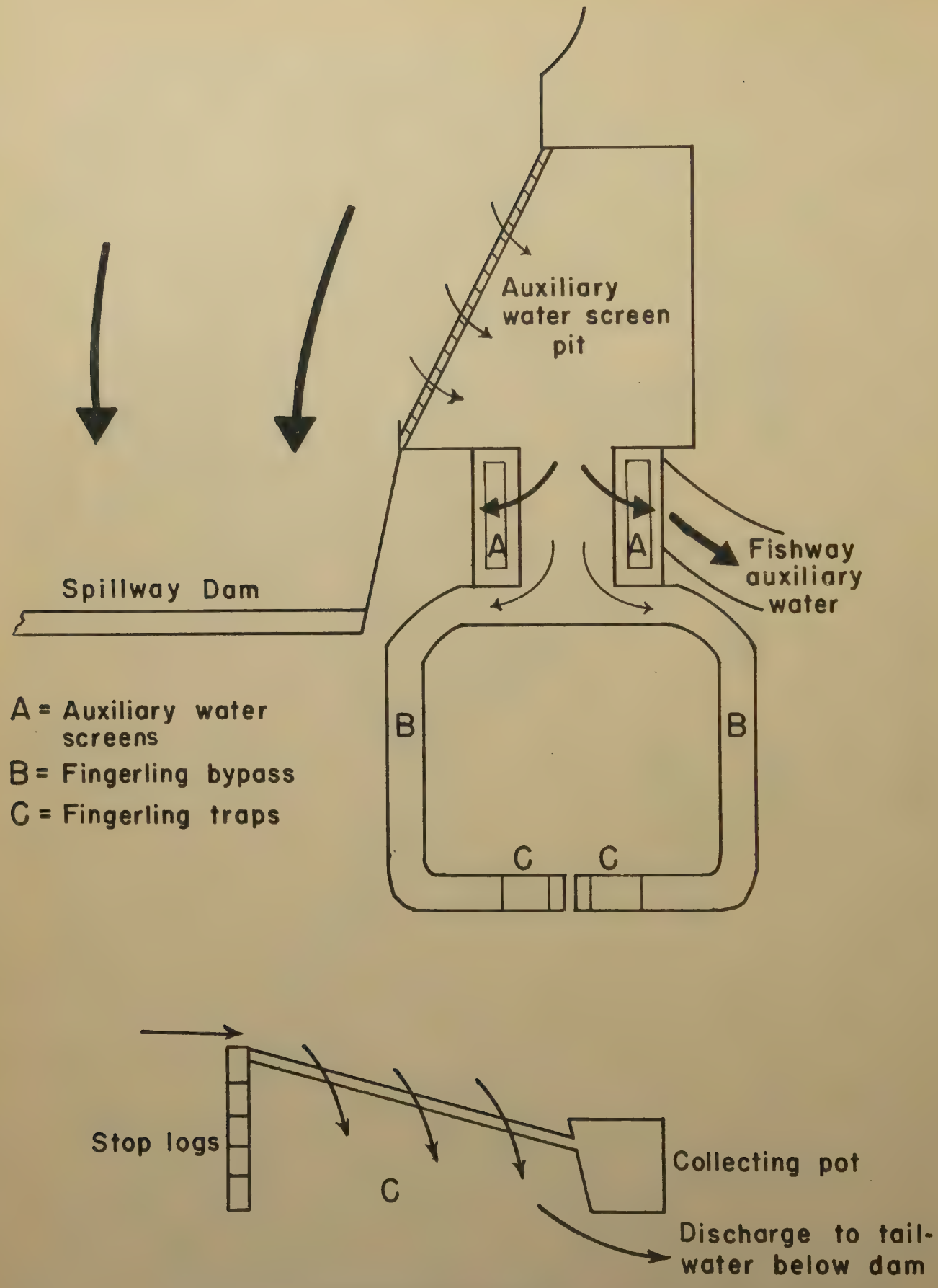


Figure 3. - Diagrammatic drawing of an auxiliary-water screen pit showing positions of fingerling bypasses and fingerling traps.

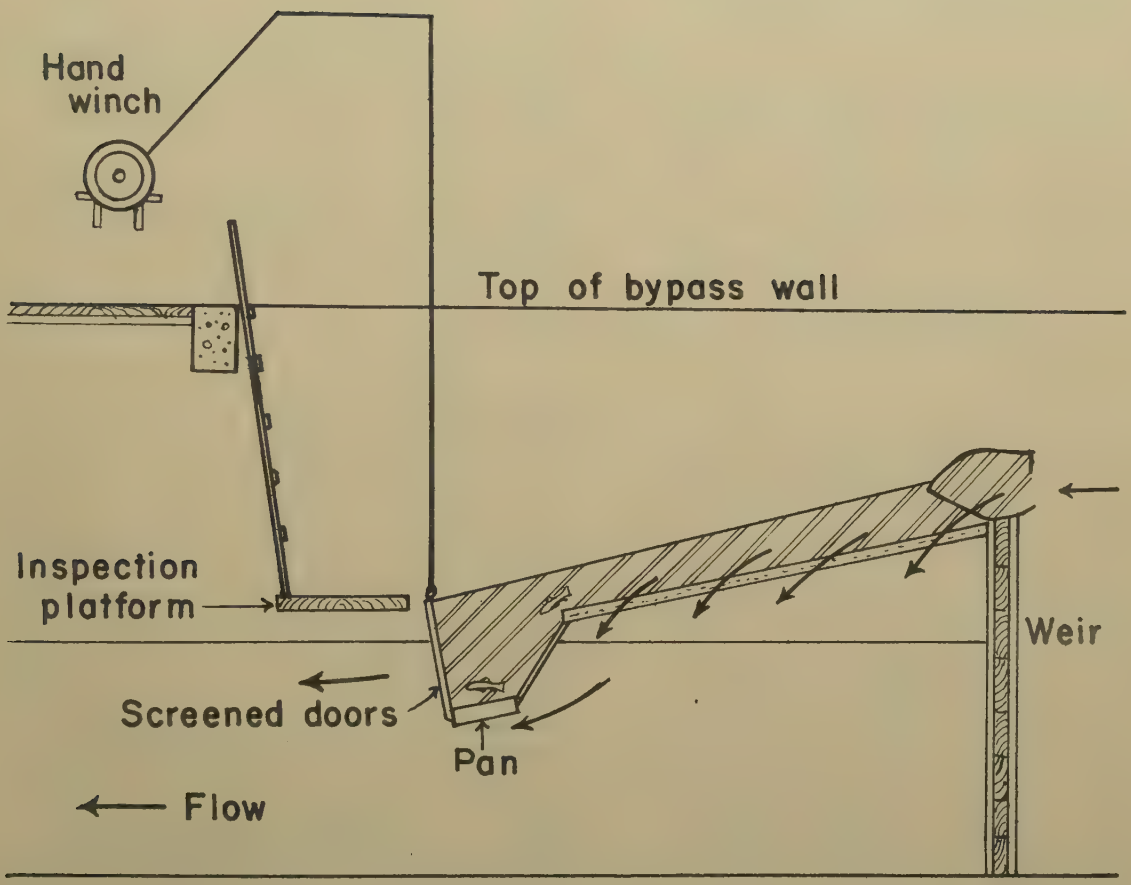


Figure 4. - Inclined-plane fingerling trap in fishing position.

welded to the downstream end of the trap is kept partly filled with water, hence all fish are washed down the screen into the collecting pot, where they are held alive.

Four of the original five fingerling traps are in operation at the present time. Tanner Creek trap was destroyed by a rock slide in December 1948; the trap was never replaced, but the bypass channel is still used by downstream migrants (see fig. 2). Partial blocking of the entrance of Tanner Creek bypass by extension of the navigation-lock wingwall in 1947 was probably responsible for the drop in catch by that trap from 49 percent of the total catch in 1946 to an average of only 2 percent in 1947 and 1948. This condition should not have any effect on the data of age, length, and time of migration.

Operation of the traps was continuous, except when fishway facility repairs or severe cold weather necessitated shutting off the water through the auxiliary-water screen pits.

MIGRATION OF WILD AND HATCHERY-REARED FISH

Time of Migration

Some downstream-migrant bluebacks pass Bonneville during all months of the year, but the fingerling-trap catches indicate that most of the migration occurs during April and May. This observation agrees with the observation of Fish and Hanavan (1948) that the bluebacks migrate from Lakes Osoyoos and Wenatchee from March through May. As explained earlier, the catch was summed by weekly periods. The "modal" week (in which the maximum number passed the dam) ranged between week 17 and week 20 (April 23 to May 20), with week 18 (April 30-May 6) and week 19 (May 7-13) each occurring 3 times in the 8 years included in this study. The modal week contained from 22 to 49 percent of the yearly catch, and averaged 36 percent of the catch for all years.

The catch rises sharply to a peak and drops off sharply, few fish being caught four weeks after the maximum catch week. Figures 5-8 and table 2 show the weekly catches. The peak in January 1946 consisted of marked hatchery fish released from the Little White Salmon station in October 1945. Some of the years have a small peak in March. In figure 9 the weekly catches are plotted as cumulative percentages, showing graphically that most of the blueback were caught within a few weeks. The weekly catches in figures 5-9 and table 2 contain a few more fish than figures and tables listing the number of migrants grouped by length and age, because in some weeks one or two migrants were caught but were not sampled. No age or length was assigned to these fish.

Age of Migrants

The ages of downstream migrants ranged from 1 to 5 years, with 93 percent being 2's or yearlings. Scales of these fish have one annulus. This aging method was developed by Gilbert (1913), who counted the age from the time the eggs were deposited. The 1's form from 0 to 2 percent of the catch, 3's from 3 to 7 percent, and 4's from 0 to 0.4 percent. Only one 5 has been caught at Bonneville. Figure 10 and table 3 show the age composition for each year.

New growth appears on most scales by May 1 at Bonneville, and a wide zone of new growth is apparent in July. An annulus appears to be forming on some scales as early as September, whereas other scales show no evidence of an annulus forming in January and February. Scale growth, therefore, is not similar for all bluebacks that pass Bonneville, even within age groups migrating during the same week. This lack of homogeneity makes the identification of false checks and the interpretation of the time when an annulus formed a constant problem, and may have caused some error in aging. A group that was especially difficult to age was composed of fish between 115 and 155 mm. that migrated in the spring. In this study these questionable blueback were grouped with the 2's. Bonneville catches of known 2's composed of marked blueback released by hatcheries in the spring were most commonly in this length group.

Future studies of the separate races comprising the Columbia River blueback

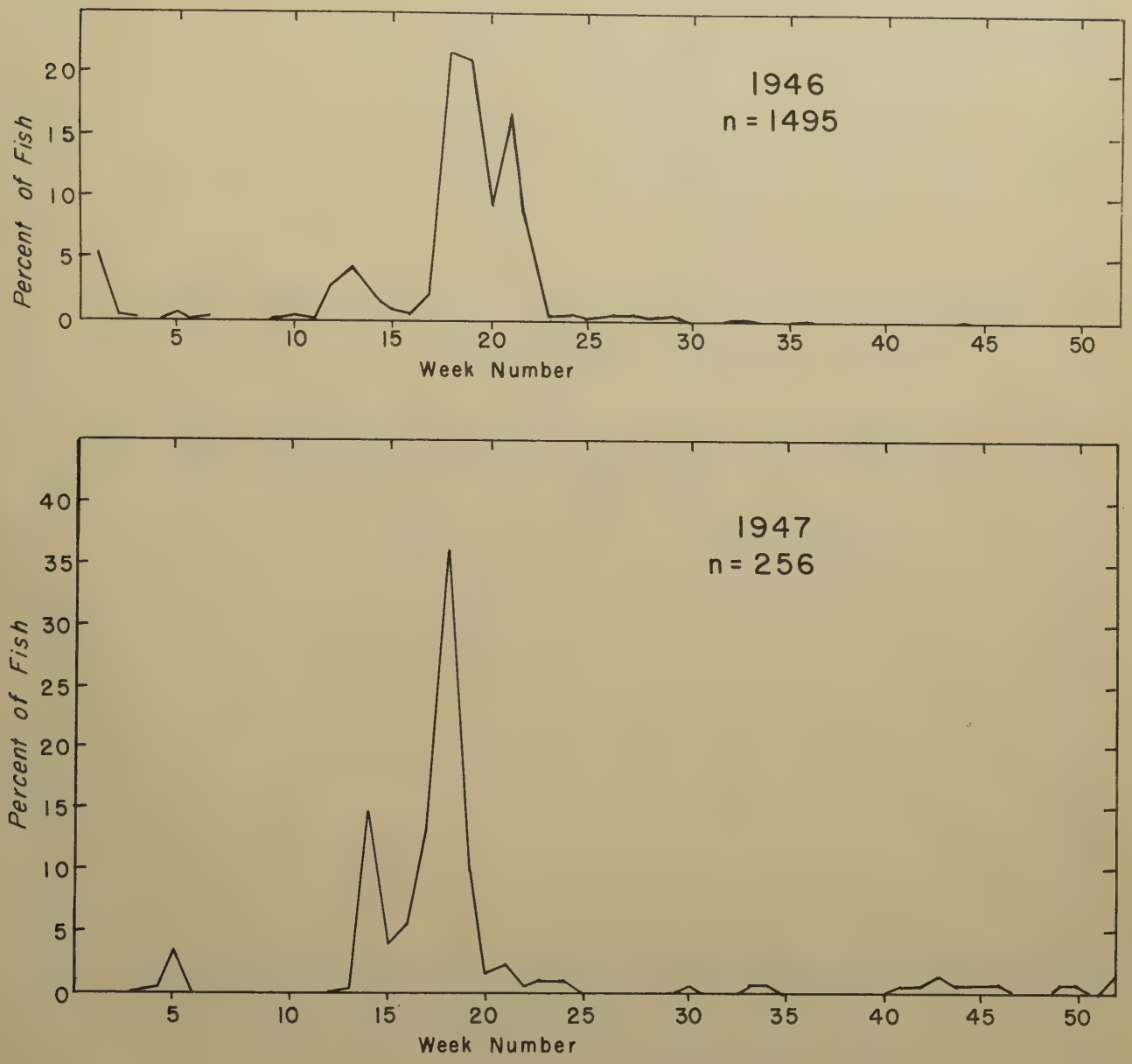
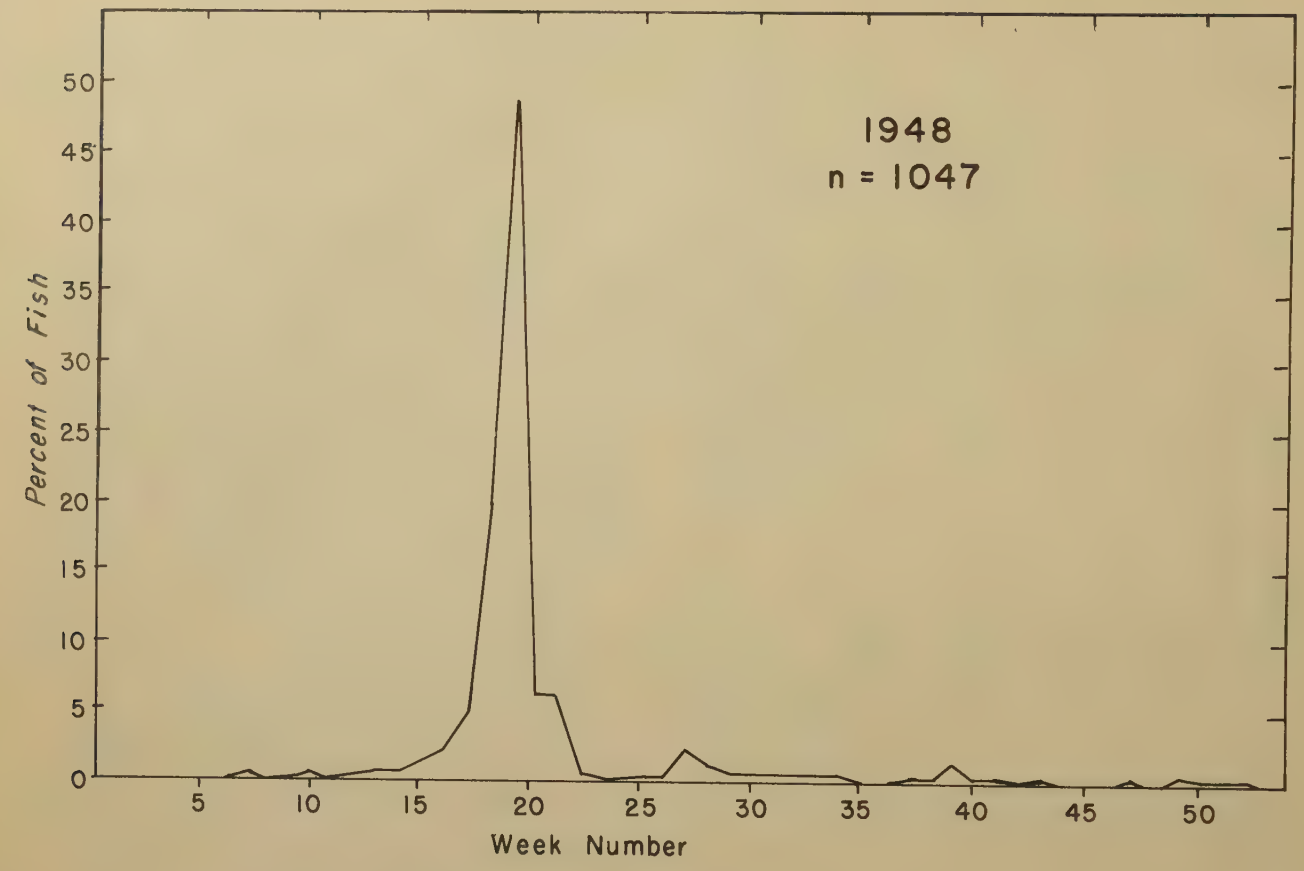


Figure 5. - Percent of downstream-migrant bluebacks caught at Bonneville Dam during each week, 1946-47.



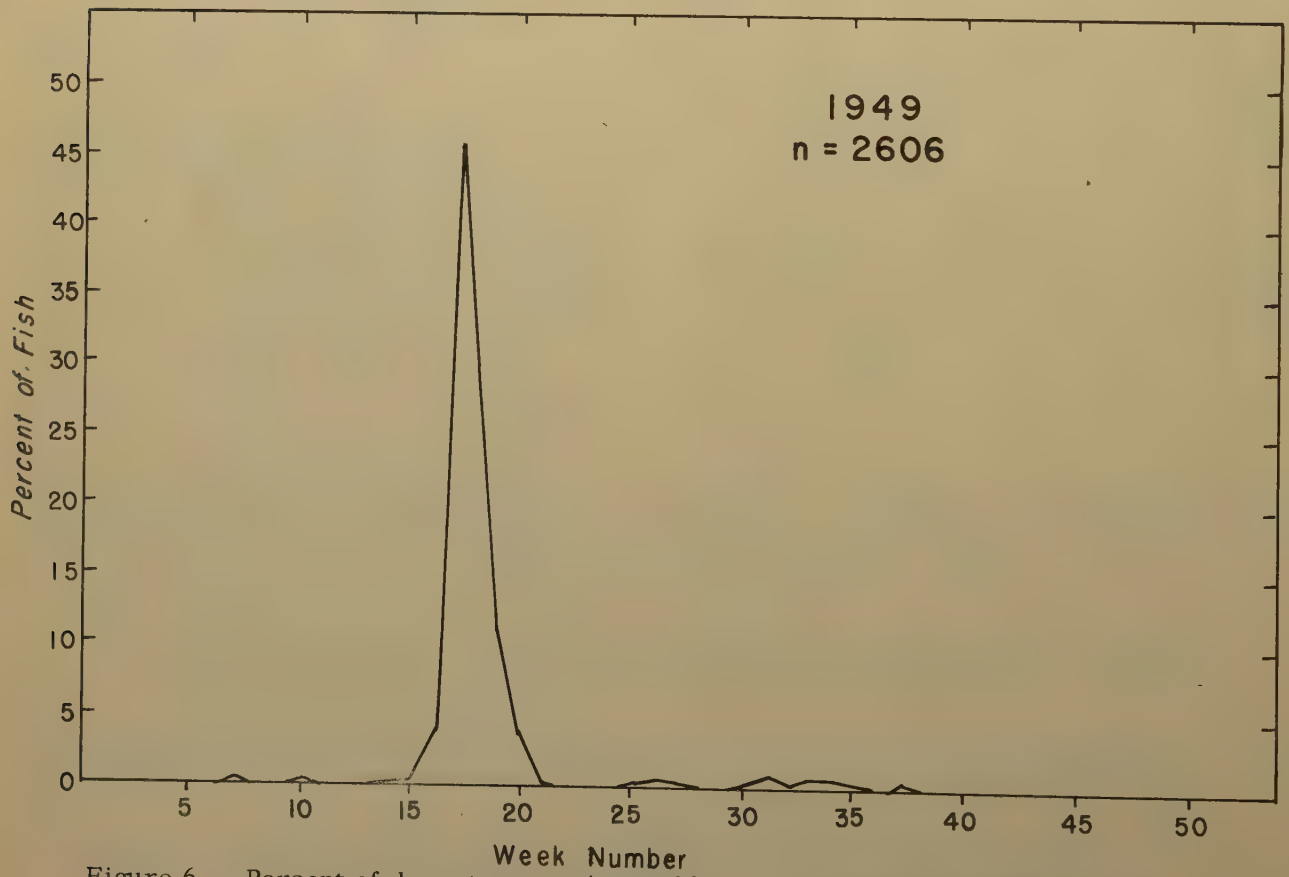
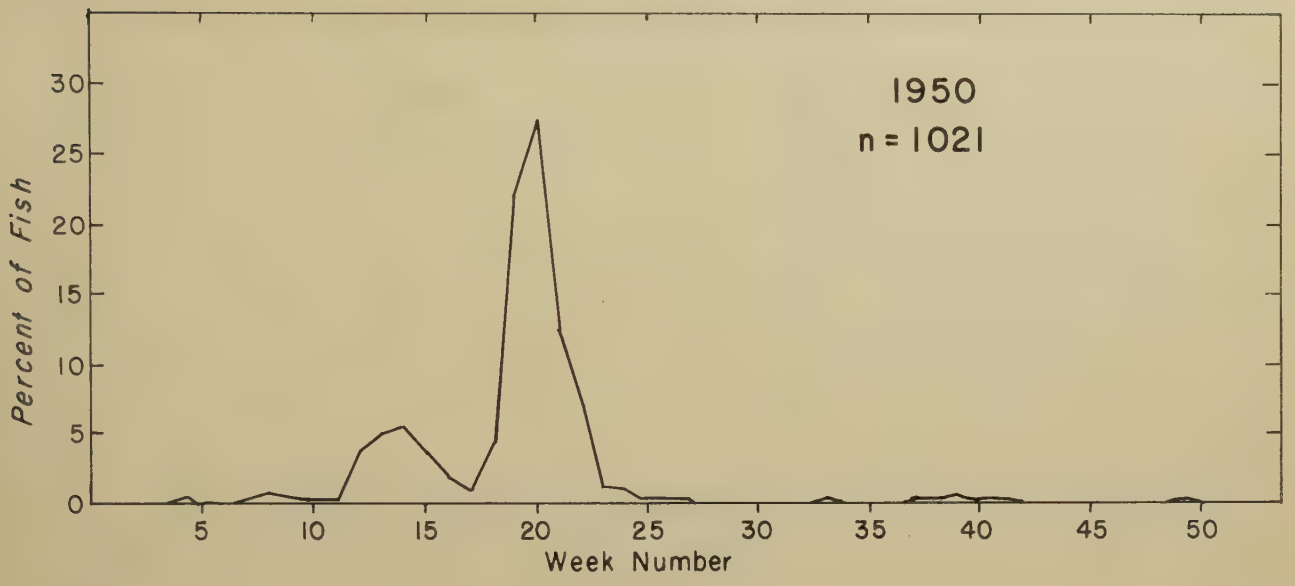


Figure 6. - Percent of downstream-migrant bluebacks caught at Bonneville Dam during each week, 1948-49.



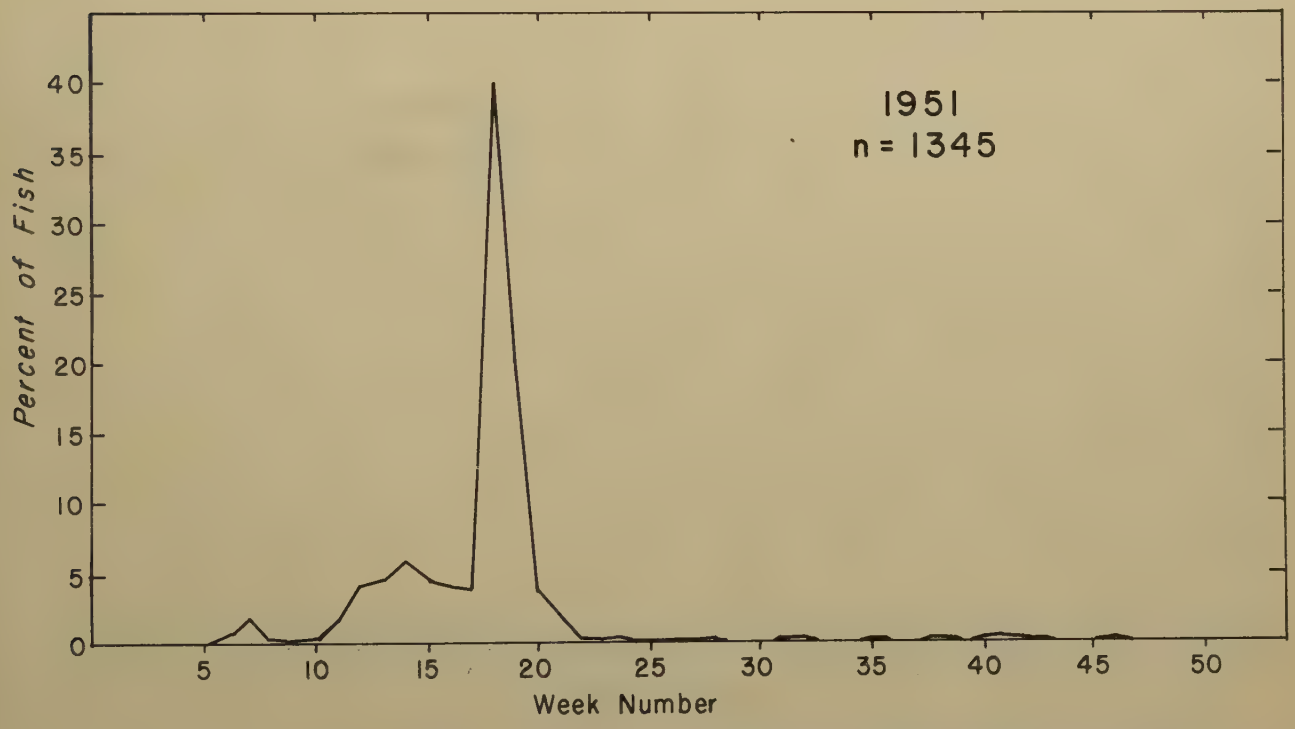
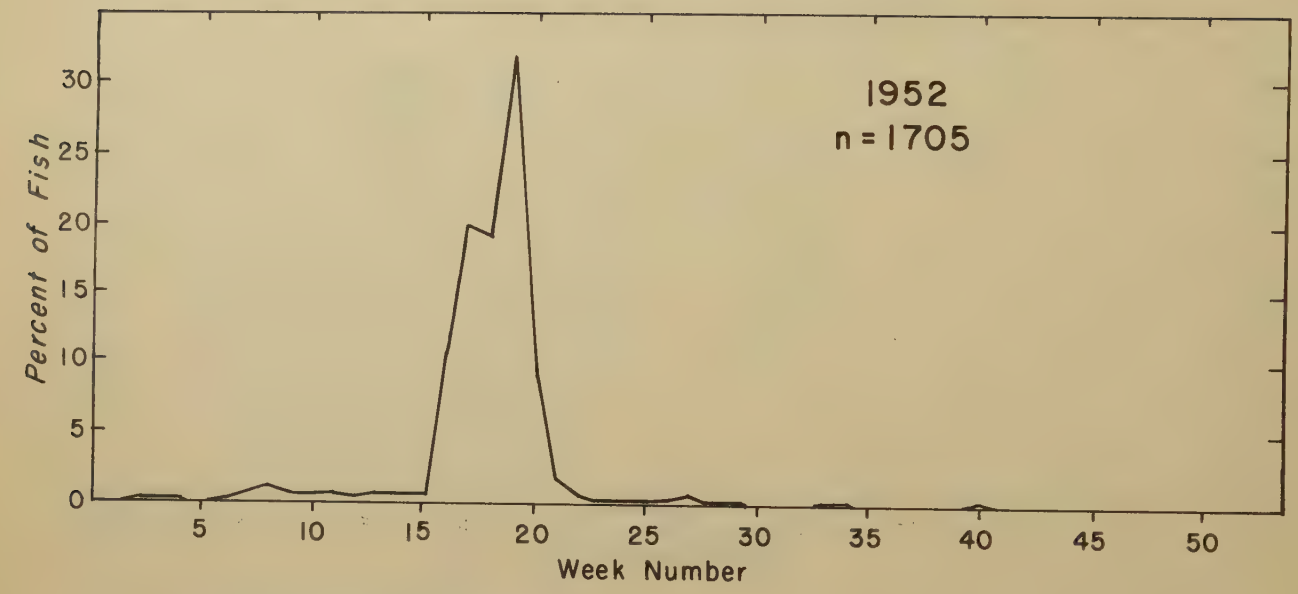


Figure 7. - Percent of downstream-migrant bluebacks caught at Bonneville Dam during each week, 1950-51.



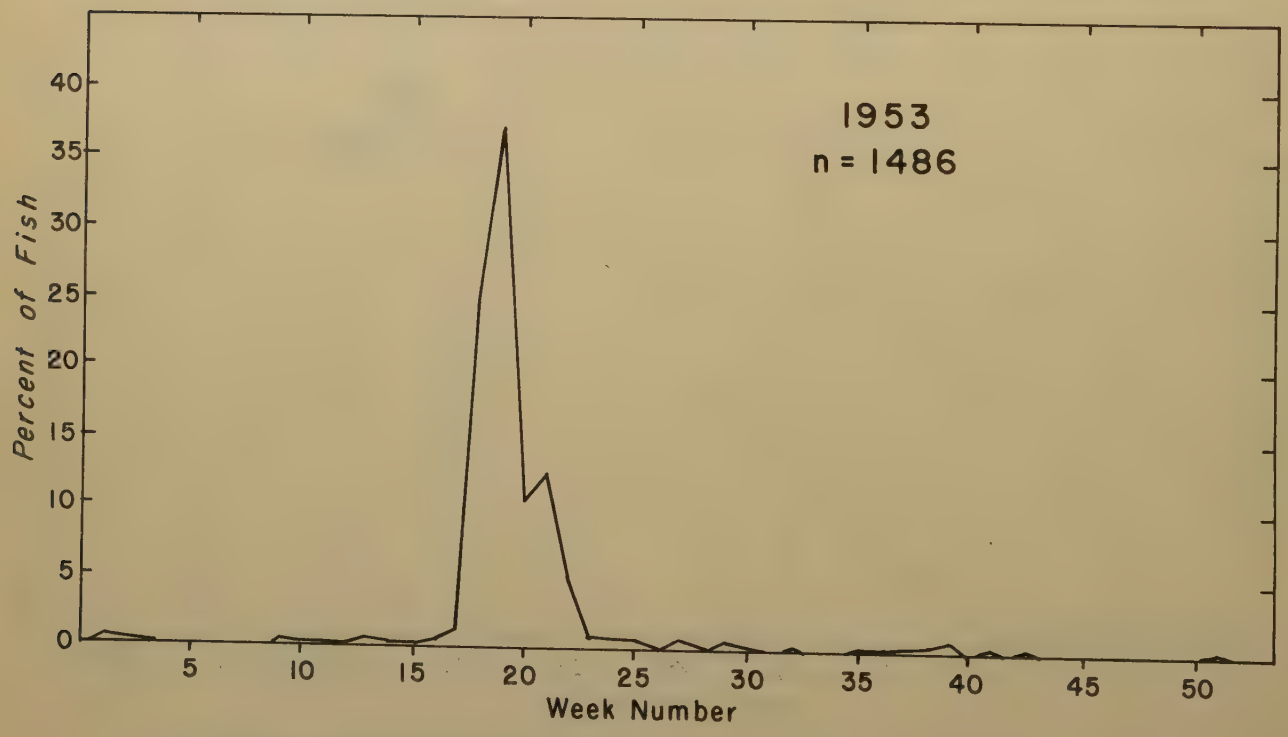


Figure 8. - Percent of downstream-migrant bluebacks caught at Bonneville Dam during each week, 1952-53.

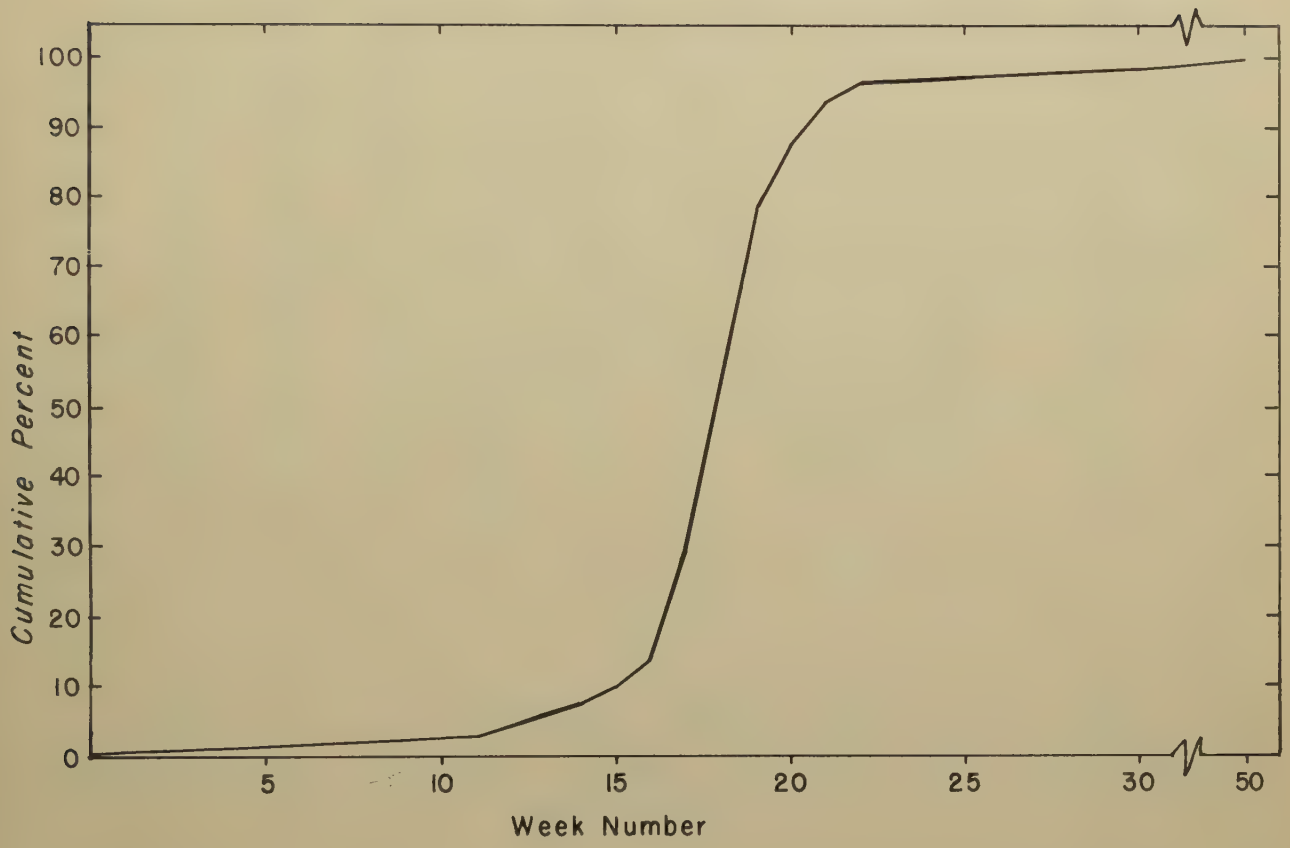


Figure 9. - Cumulative percent of downstream-migrant bluebacks caught during each week at Bonneville Dam: Average of 1946-53 catches.

Table 2.--Number of bluebacks caught in fingerling-bypass traps at Bonneville Dam during weekly periods, 1946-53.

Week ending	Week No.	1946	1947	1948	1949	1950	1951	1952	1953
Jan. 7	1	82							
14	2	6			1			1	7
21	3	1						1	4
28	4		1			2		2	3
Feb. 4	5	7	9						
11	6						9	1	
18	7	1		2	2	4	26	10	
25	8				1	9	6	20	1
Mar. 4	9	1		1	1	6	1	6	6
11	10	6		4	2	1	5	8	3
18	11			1		1	23	12	3
25	12	40		2	1	39	56	9	1
Apr. 1	13	64	1	5	1	51	60	13	7
8	14	33	38	5	5	55	79	12	5
15	15	14	10	13	9	37	61	12	3
22	16	9	14	24	105	21	55	180	8
29	17	30	34	51	1190	10	50	340	21
May 6	18	326	93	207	772	47	540	308	364
13	19	314	26	509	294	224	272	545	556
20	20	142	4	64	108	280	52	155	154
27	21	256	6	63	9	127	21	33	184
June 3	22	134	1	4	2	71		9	74
10	23	3	2			12	3	1	10
17	24	4	2		1	11	1	1	9
24	25	2		1	4	1	3	2	9
July 1	26	5		2	12	1	2	3	1
8	27	5		24	8	1	1	12	9
15	28	2		13	1		1	3	2
22	29	3		5	1		1	2	7
29	30		1	4	3				3
Aug. 5	31			3	24				
12	32	2		4	4		2		2
19	33	1	1	4	16	2	1	1	
26	34		1	2	16			2	
Sep. 2	35			1	4		2		1
9	36	1			1				1
16	37			1	4	1	1		5
23	38			1	1	1	1		7
30	39			11		3			1
Oct. 7	40			2		1	3	1	11
14	41		1	2		1	4		
21	42		1	1	1		1		2
28	43		3	2	1		1		
Nov. 4	44	1	1						1
11	45		1						
18	46		1				1		
25	47			1					
Dec. 2	48								
9	49		1	3		1			
16	50		1	2	1				
23	51			2					1
31	52		2	1					
Total		1,495	256	1,047	2,606	1,021	1,345	1,705	1,486

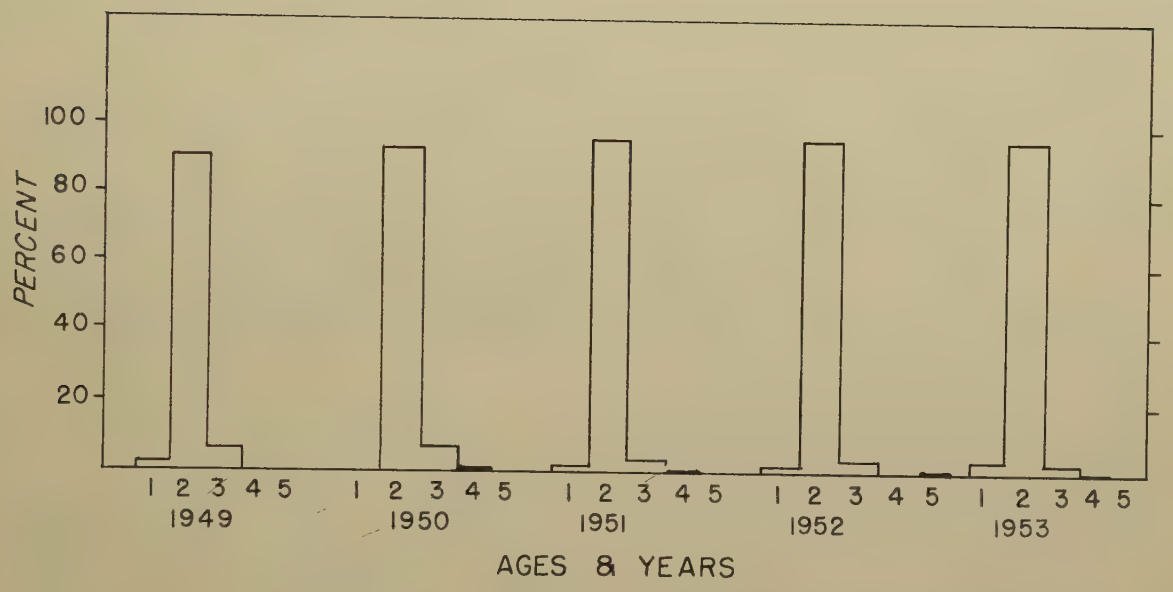


Figure 10. - Age composition of downstream-migrant bluebacks caught at Bonneville Dam, 1949-53.

Table 3.--Number of bluebacks of each age caught in the fingerling traps at Bonneville Dam, 1949-53.

Year	Number of age--					Total
	1	2	3	4	5	
1949	59	2,335	200			2,594
1950		956	63	1		1,020
1951	12	1,281	46	5		1,344
1952	21	1,616	66		1	1,704
1953	37	1,410	34	3		1,484
Total	129	7,598	409	9	1	8,146
Percent	1.6	93.3	5.0	0.1	0.01	

population may resolve the difficulties mentioned above, but the data are not available at this time. Rather than withhold all the information in this report until scale studies of the Columbia River blueback salmon are complete, the ages are presented as the best determinations possible at this time.

We have little knowledge how the age composition of the downstream migrants compares with that of the adult returns. Scale samples from 280 adult bluebacks of the Okanogan River 1953 run showed that of 279 fish that had migrated seaward in their second year, 271 returned in their third year and 8 in their fourth year. None had migrated seaward as 1's. A single 5-year-old fish had migrated to the ocean as a 3 [2/]. Adult 3-year-olds have been observed in the Okanogan River in other years; however, it is known that most Columbia River bluebacks mature in 4 years. Apparently the 1953 Okanogan River run was anomalous. Observers at Bonneville Dam and Celilo Falls on the Columbia River noted that the bluebacks that returned in 1953 appeared to be smaller than those in previous years. The downstream-migrant age composition in 1952 was similar to that in the other years of this study, so age composition of the downstream migrants would not explain this abundance of adult 3's.

River Conditions During Modal Weeks

As previously stated, the Bonneville catches indicate that the peak migration of bluebacks past the dam occurs in the spring and extends for a relatively short period. During this period the water temperature, river flow, and turbidity are increasing, but since these factors at Bonneville may not be related to the same factors at Lakes Osoyoos and Wenatchee their effect on migration cannot be evaluated accurately.

River flow could affect the Bonneville catch data by altering conditions at the dam, for the flow into the auxiliary-water screen pits is not directly proportional to river flow. As the river rises in the spring, and the spillway gates are opened, the fingerling traps sample a lesser proportion of the total flow; if the proportion of downstream migrants sampled is inversely proportional to flow, then figures 5-8 may not represent the exact percentage of migrants passing the dam each week. However, when corrected catches were computed for the 1949-53 data by multiplying the actual catch by the ratio of river flow to auxiliary-water flow, the modes in figures 5-8 were not changed. The corrected catches do not necessarily represent the true abundance of downstream-migrant bluebacks passing the dam, because the number of fingerlings that pass through the spillway and powerhouse channels as compared to the number that enter the auxiliary-water screen pits is not known.

Foerster (1937) in his work at Cultus Lake found that the temperatures during January, February, and March have an effect on the time of migration, and that migration does not start until the water temperature reaches 40°F. This condition could also affect the time of migration of Columbia River bluebacks but no water-temperature records are available for Lakes Osoyoos and Wenatchee. A few downstream-migrant bluebacks have been caught at Bonneville when the water temperature was less than 40°F.

Age Groups and Time of Migration

The earliest appearance of unmarked 1's in the catch was in week 19 in 1951; the 1's caught that year in weeks 17 and 18 were marked hatchery fish. Most of the 1's were caught after week 25. A few continued to migrate from that date until the end of the year.

The 2's dominated the catches throughout the year, but were especially abundant in the peak migration period each spring.

The 3's have a migration pattern similar to the 2's but are much less abundant. The 4's and 5's migrate only during the spring months. May 28 (week 22) was the latest date either of these age groups appeared.

2/ Age-analysis files of the Pacific Salmon Investigations, Fish and Wildlife Service, 2725 Montlake Boulevard, Seattle, Washington.

Appendix tables 1-5 give the number of each age group by weekly periods from 1949 to 1953. Sometimes hatchery releases contribute fish that confuse the picture. In 1951 a release of marked 1's from Winthrop station appeared in weeks 17 and 18 at Bonneville. Normally, 1's would not be expected in the catch that early in the year. In 1953, two 1's that were probably from a Little White station release were caught in weeks 21 and 22. This catch, again, was earlier than this age group usually appears.

Lengths of Migrants

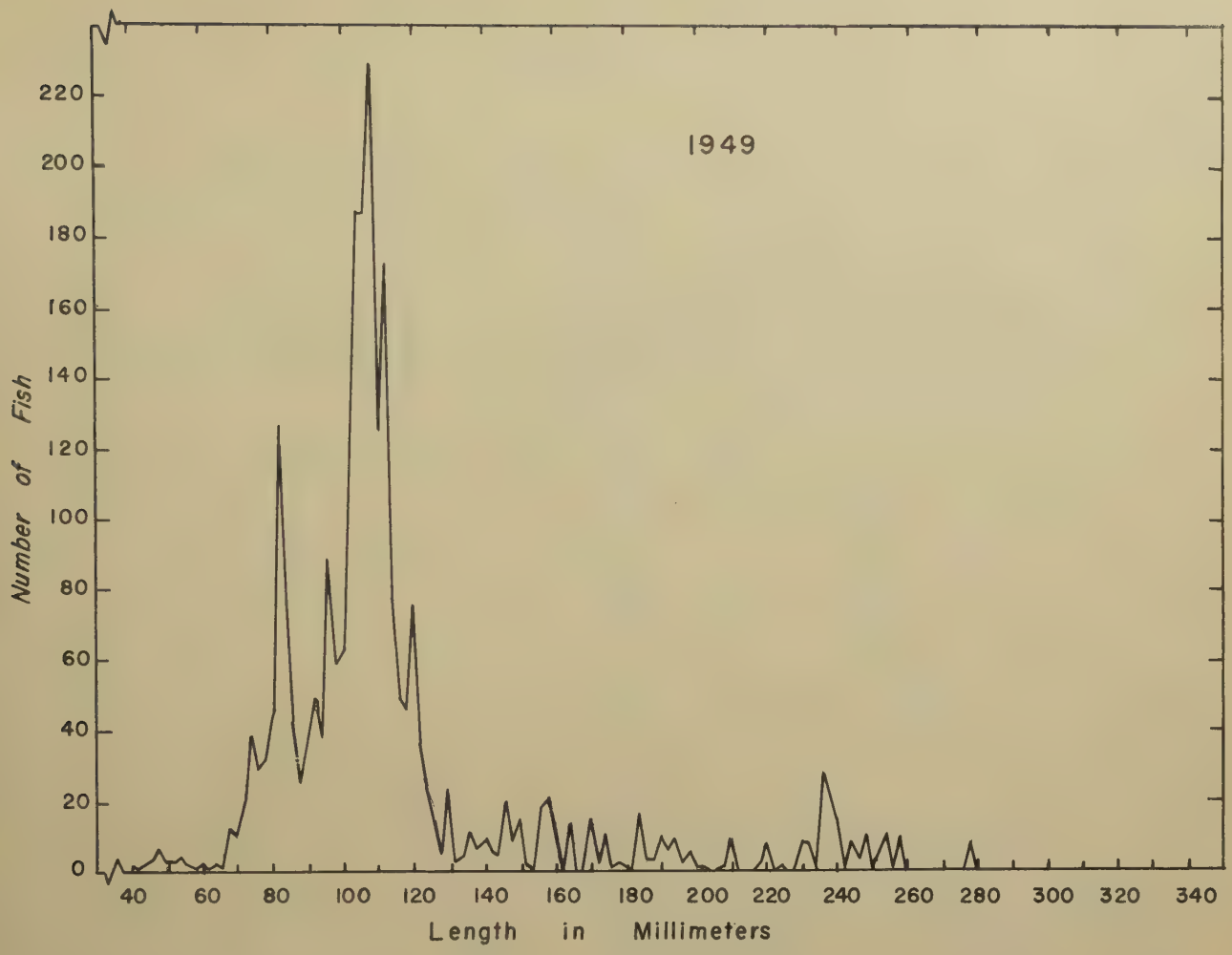
The lengths of blueback migrants, even within age groups, showed wide variation, partially caused by the growth added during the summer. Another possible cause of variation in lengths of bluebacks caught at Bonneville is that the population is a mixture of fish from Lakes Osoyoos and Wenatchee, and to some extent from other lakes in the Columbia River system. The Leavenworth and Winthrop hatcheries, which obtain their eggs from the Lake Wenatchee stock, produce most of the artificially reared bluebacks released into the Columbia River system. These hatcheries formerly released blueback fingerlings into Lakes Osoyoos and Wenatchee, and to some extent into the Wenatchee, Entiat, and Methow Rivers, but in recent years most of the hatchery production has been released into Lake Wenatchee and its tributaries. Some of the downstream-migrant bluebacks might be kokanees (land-locked bluebacks) from any of several lakes in the Columbia system. Both live and dead kokanees have been found below Grand Coulee Dam, and some of the survivors on their way to the ocean probably would be caught at Bonneville. All of these variables could affect the length data from the Bonneville fingerling-trap catches.

Gangmark and Fulton (1952) state that there is quantitatively more plankton in Lake Osoyoos than in Lake Wenatchee, and that the kokanees in Osoyoos are larger. A logical assumption would be that bluebacks in Osoyoos also are larger. No separation of these populations by length-frequency graphs is consistently apparent, as shown by figures 11 and 12 and figures 13-17. The average sizes of the 2's are slightly bimodal before week 25. Perhaps the separation of the different races is obscured by one of the races being more abundant.

The 1's have ranged from 39 to 116 mm., with the largest before week 25 being 84 mm. (week 24 in 1952). Those over 90 mm. do not appear until later in the year. The 1's ranging from 39 to 50 mm. caught in 1949 are believed to be part of a Little White hatchery release. Another Little White release probably contributed the two fish, of 52 and 58 mm. caught in weeks 21 and 22 in 1953. Three marked 1's from a Winthrop hatchery release were caught in weeks 17 and 18 in 1951 and measured from 62 to 71 mm. The 1's released by Little White hatchery appear to be smaller than the average of the bypass catches, while those released by the Leavenworth and Winthrop stations are larger than the average migrant at the time of release.

The lengths of the 2's ranged from 64 to 247 mm. The small 2's from 64 6o 80 mm. usually migrate in the spring, and have never been confused with the 1's. The peak migration period consists principally of 2's from 80 to 120 mm. Fish and Hanavan (1948) stated that the blueback migrants from Lakes Osoyoos and Wenatchee were all yearlings that ranged from 3.5 to 5 inches, or 89-127 mm. Most of the spring-migrant 2's in the present study were in this range. Few spring-migrant 2's were over 170 mm. By October, all 2's were over 150 mm. There were no 1's in the fall and winter catch of any year that could be compared with the large 2's from 130 to 194 mm. caught the following spring. A spring release of marked 2's from Winthrop ranged in length from 138 to 194 mm. in the Bonneville catch data. If these lengths are consistent for other spring releases, these large 2's may be hatchery fish, but more data are necessary to prove or disprove this possibility. One 112-mm. marked blueback from a fall release was measured (in week 19 in 1953); a second specimen from the same release was caught, but it was not measured. Hatchery releases are discussed on page 26.

All 3's were over 160 mm. by week 25, with the exception of one fish that was 148 mm. The largest 3 caught before week 25 was 301 mm., and the largest after was 292 mm. The 4's



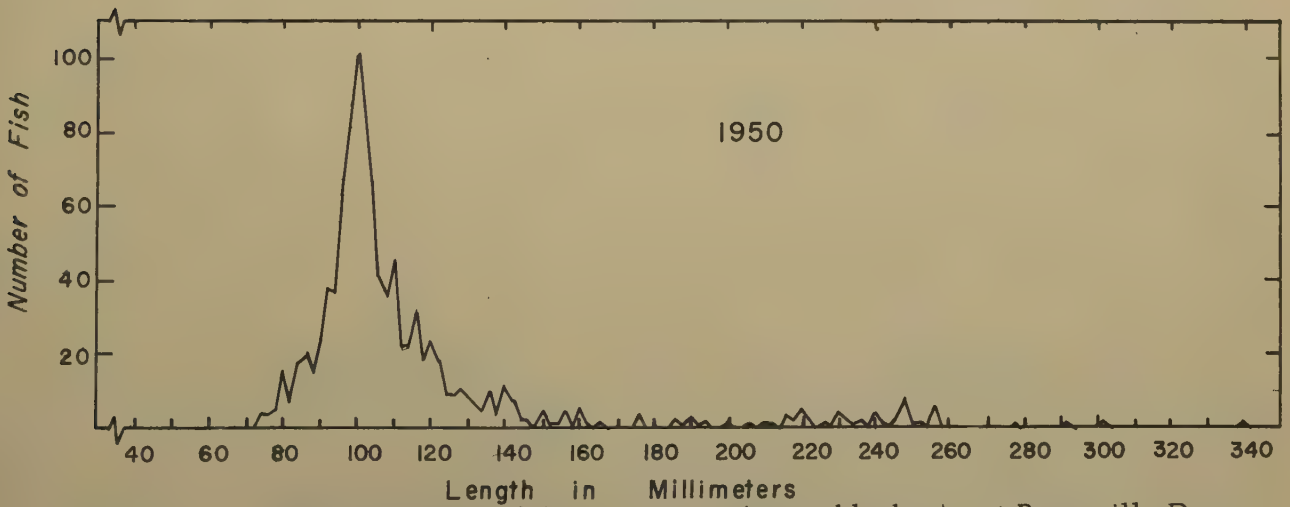


Figure 11. Length frequency of downstream-migrant bluebacks at Bonneville Dam, 1949-50.

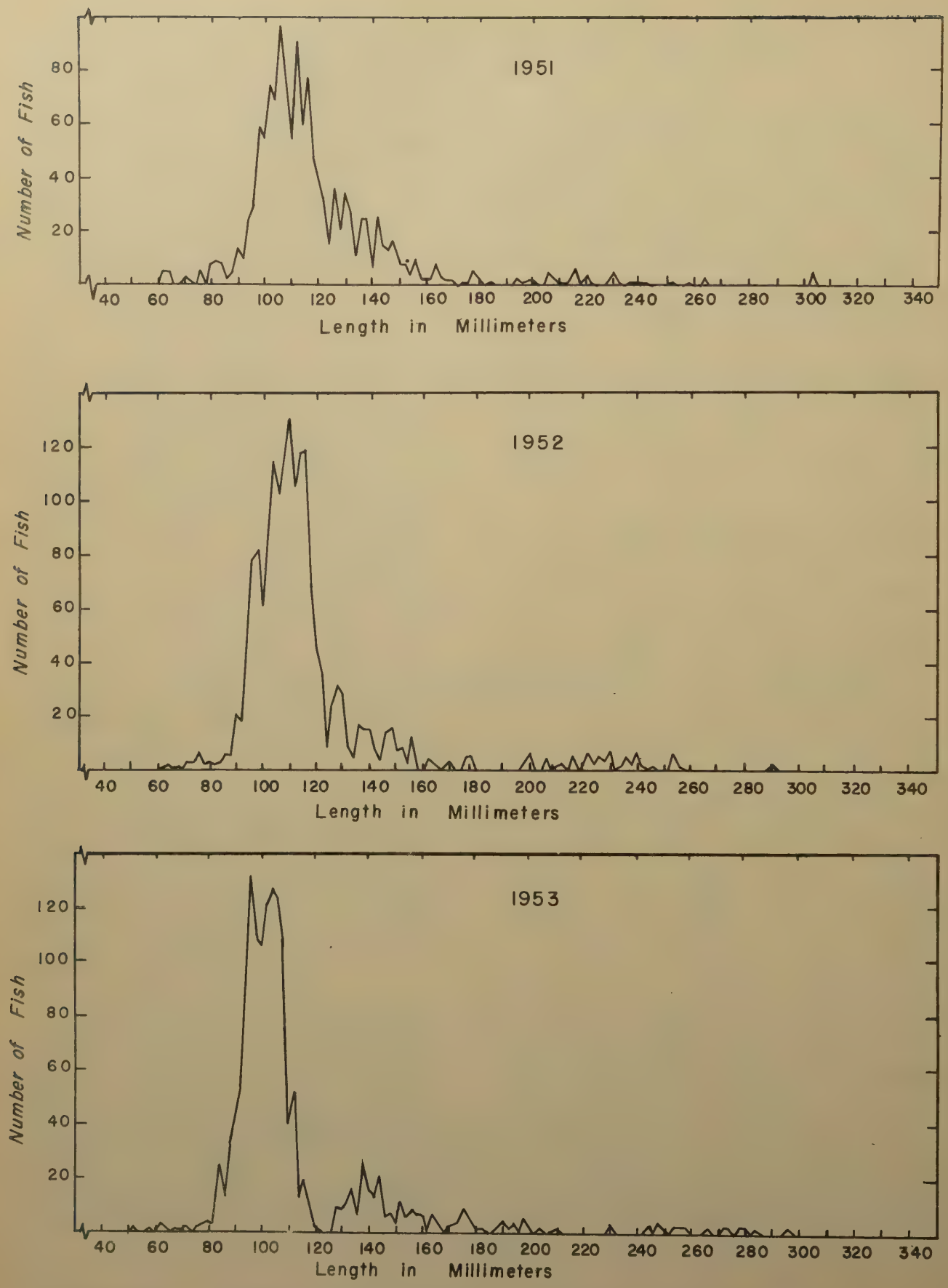


Figure 12. - Length frequency of downstream-migrant bluebacks caught at Bonneville Dam, 1951-53.

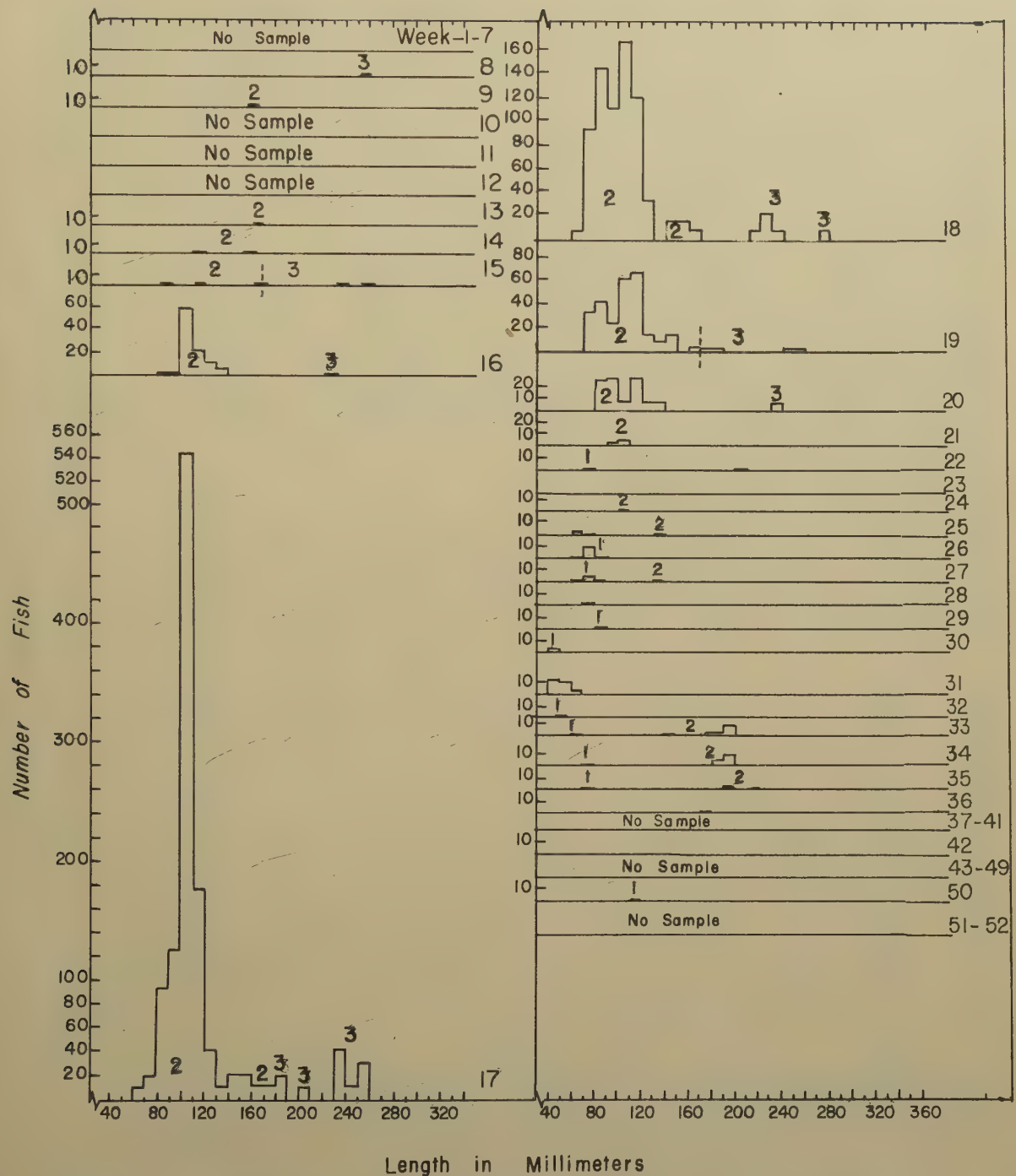


Figure 13. - Length frequency of downstream-migrant bluebacks in weekly samples, 1949.

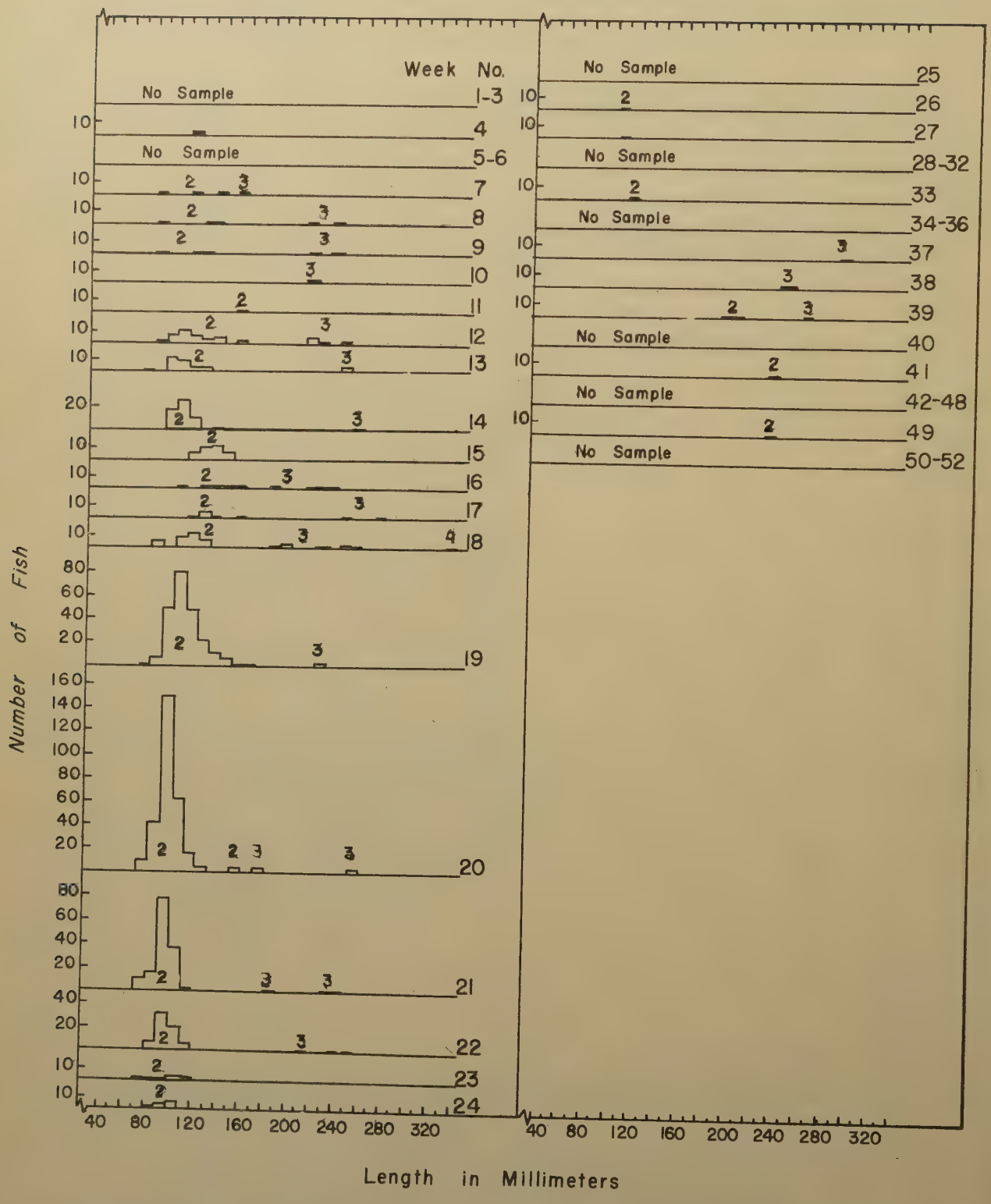


Figure 14. - Length frequency of downstream-migrant bluebacks in weekly samples, 1950.

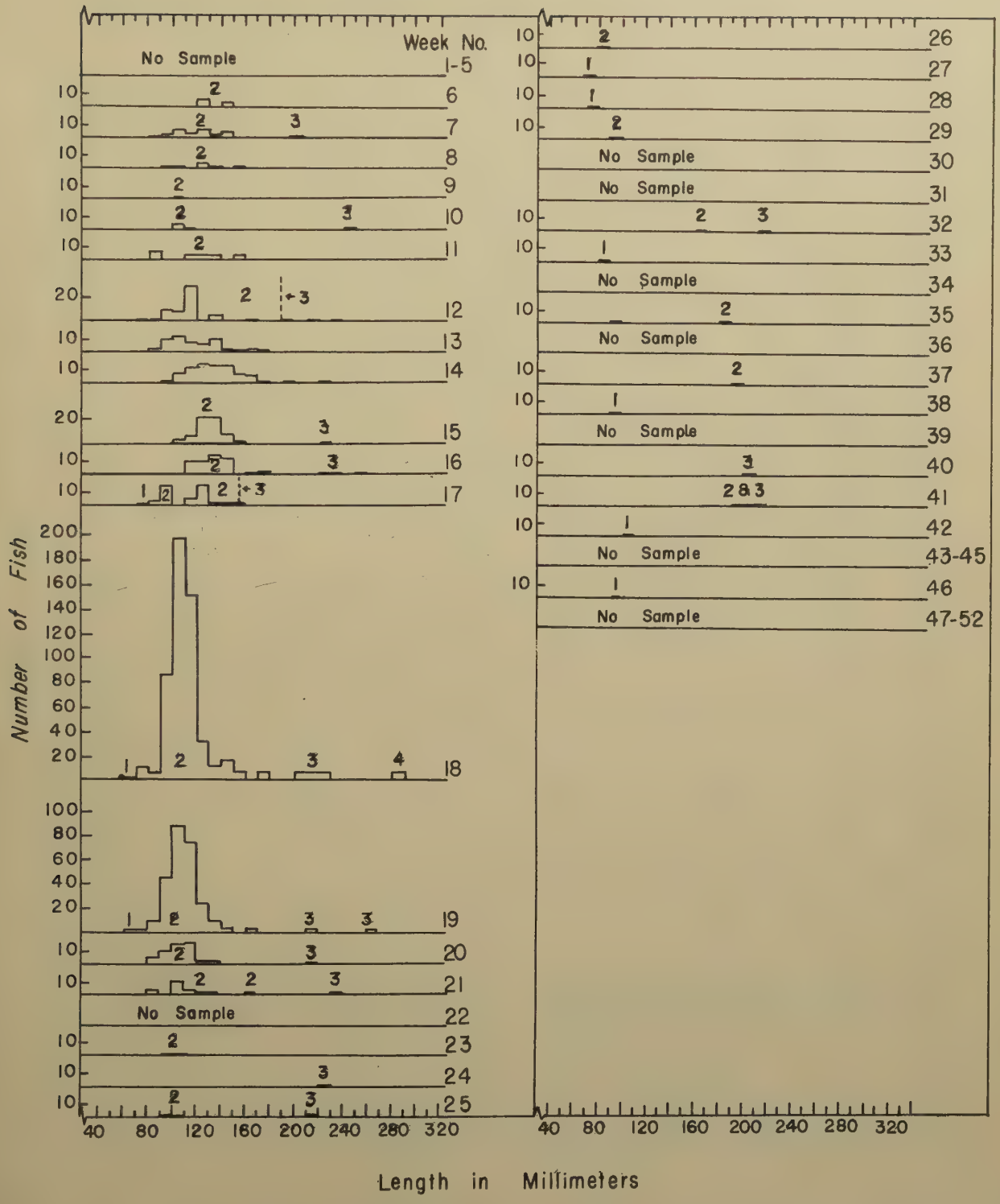


Figure 15. - Length frequency of downstream-migrant bluebacks in weekly samples, 1951.

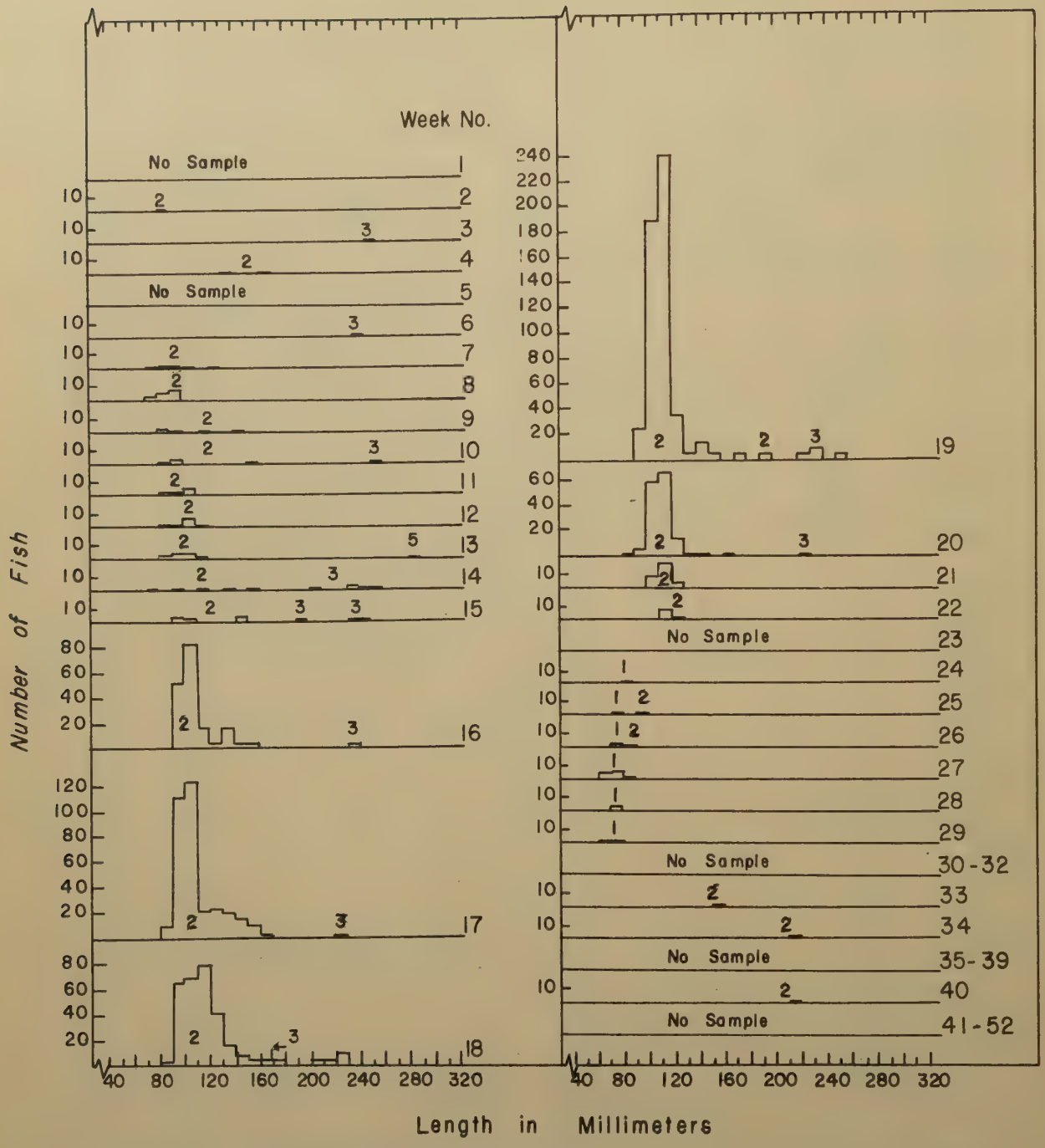


Figure 16. - Length frequency of downstream-migrant bluebacks in weekly samples, 1952.

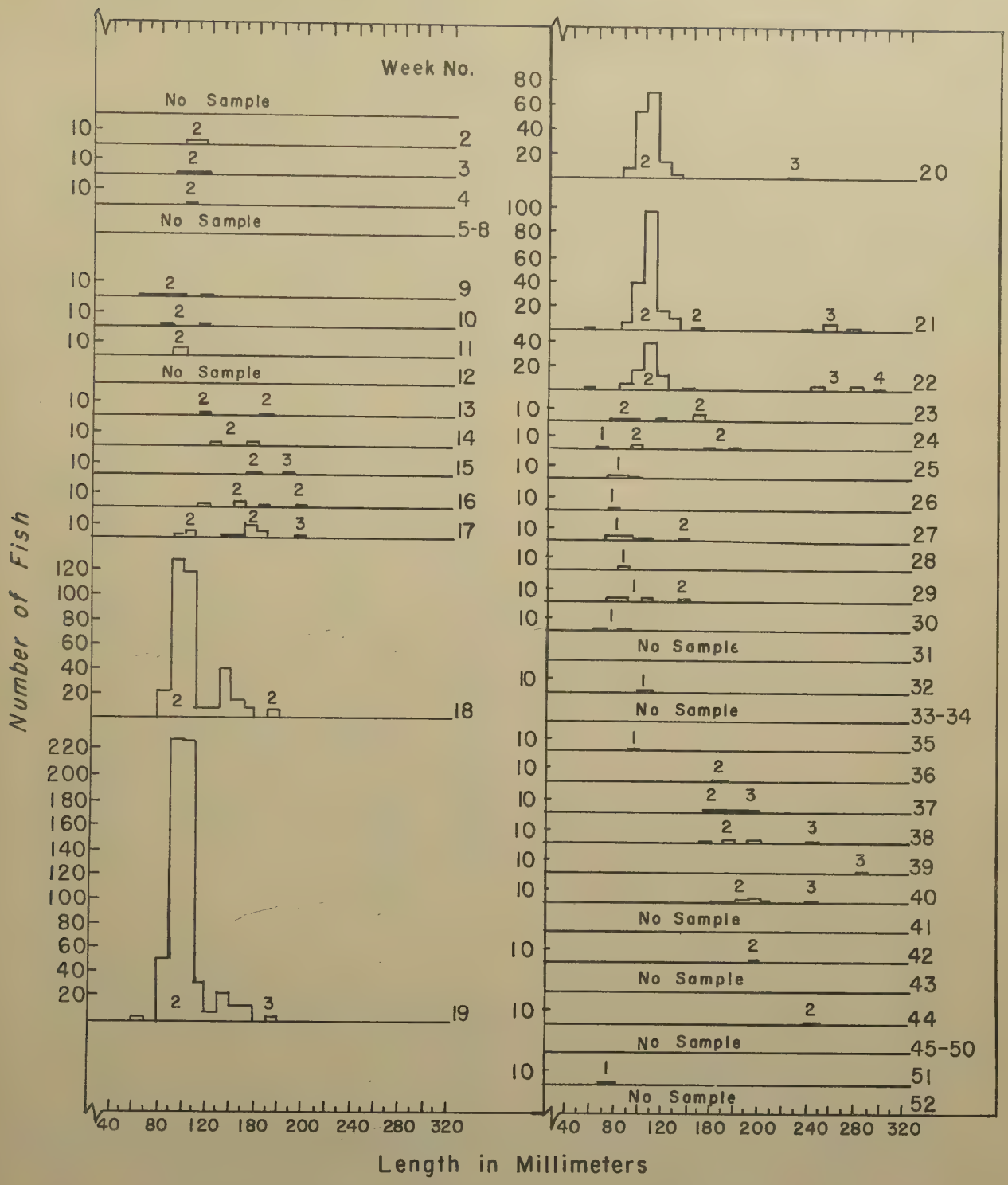


Figure 17. - Length frequency of downstream-migrant bluebacks in weekly samples, 1953.

ranged from 272 to 340 mm. Only one 5 has been caught, and it measured 289 mm. Appendix tables 6-10 give the number of bluebacks of each age in each 10-mm. interval.

The lengths of each age group in the preceding paragraphs include the extremes of the 1949-53 data; thus the range of the lengths is extended by any differences in growth that exist between the years. Figure 18 shows the maximum, minimum, and average lengths of each age group, with 95 percent confidence limits of the ranges and means. The 2's tend to be skewed more than the other ages, possibly indicating that the growth rate of bluebacks in fresh water is greatest during the summer of the second year. Large 2's measuring over 200 mm. are caught in the fall at Bonneville.

Estimating Ages from Lengths

Foerster (1929) observed that the prediction of ages from lengths looked promising for Cultus Lake sockeye (O. nerka) migrants. Estimating ages of Columbia River bluebacks is more difficult. The Cultus Lake fish are of a single population that migrates within a short period in the spring, whereas the Columbia River population is mixed and migrates throughout the year.

Time of migration and lengths of age groups have been discussed. Most of the downstream-migrant blueback can be separated by using these data. Complete separation of the age groups is simpler if the year is divided at week 25 (June 18). Before week 25, scales should be read for lengths 84 mm. and less to separate the 1's and 2's, for lengths between 160 and 200 mm. to separate the 2's and 3's, and for all those over 280 mm. to separate the 3's, 4's, and 5's. Spring hatchery releases contribute fish that are larger than the wild migrants, and extend the maximum lengths for the 1's and 2's before week 25. After week 24, scales should be read for fish 120 mm. and less to separate the 1's and 2's, and for all over 190 mm. to separate the 2's and 3's.

MIGRATION OF MARKED HATCHERY-REARED FISH

Rate of Travel of Marked Fish

All of the information on rate of travel used in this report comes from the catches of marked fish which were released from hatcheries above Bonneville. It is realized that these marked fish may differ in rate of migration from the unmarked and wild fish. Although it is difficult to draw conclusions, apparently fish released in the fall do not migrate until the following spring, whereas the spring-released fish migrate immediately, but not as a single school.

The fastest and slowest moving fish came from the same lot of 25,000 1's, marked adipose, which were released at Winthrop on April 18, 1951. On April 26, one of these fish was caught at Bonneville; this fish averaged a little over 50 miles a day. Two others were taken shortly afterward, one on the 1st and one on the 2d of May 1951. Then on September 11, 1953, a fourth was caught, 877 days after the date of release. Hatchery releases are listed in tables 4-12.

The above release excluded, the best indication is that the rate of travel of bluebacks released in the spring from Leavenworth and Winthrop averages 12 to 25 miles a day. A spring release from Little White averaged less than 2 miles a day.

Catches of Marked Fish

Leavenworth and Winthrop hatcheries are approximately 350 and 420 miles above Bonneville Dam; Little White hatchery is approximately 20 miles above Bonneville. More marked bluebacks were caught from fish released in the spring than those released in the fall from Leavenworth and Winthrop; more marked blueback were caught from a fall than from a spring release from Little White. No bluebacks were caught at Bonneville from 49,286 marked 2's released in October and November into the Metlow River by Winthrop hatchery; 27 marked 2's were caught from 42,332 released in March into the same river. Three bluebacks were

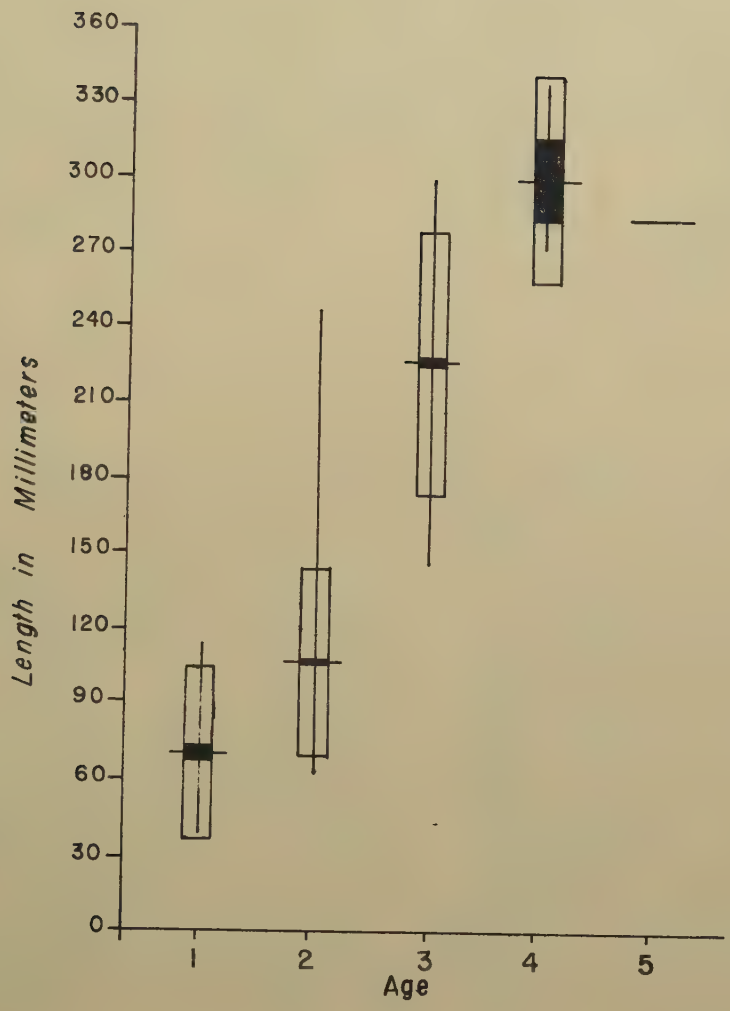


Figure 18. - Maximum, minimum, and average lengths of each age group of downstream-migrant bluebacks, 1949-53 average. White boxes represent two standard deviations on each side of the mean; black boxes represent 95-percent confidence limits of the mean.

Table 4.--Hatchery releases of bluebacks and kokanees, 1945

Date released	Hatchery	Number	Brood year	Released into
Mar. & Apr.	Winthrop	86,788	1943	Methow River
Oct. 15	Little White	25,351 1/	1944	Drano Lake
Oct. -	Leavenworth	292,338	1944	L. Wenatchee
Nov. 7	Leavenworth	84,069 2/	1944	L. Wenatchee
Nov. 9-15	Leavenworth	85,648 3/	1944	L. Wenatchee
Total		574,194		

1/ Marked

2/ 51,923 marked

3/ Kokanee; 60,128 marked

Table 5.--Hatchery releases of bluebacks and kokanees, 1946

Date released	Hatchery	Number	Brood year	Released into
Mar. 12	Leavenworth	29,189 1/	1944	Icicle Creek
Mar. 14-19	Winthrop	64,939	1944	Methow River
Mar. 19	Little White	54,839 2/	1944	Drano Lake
Apr. -	Bonneville	391,040 3/	1944	Tanner Creek
Sept. 27	Leavenworth	40,533	1945	L. Wenatchee
Sept. 30	Leavenworth	90,652	1945	L. Wenatchee
Oct. 1-7	Leavenworth	510,461	1945	L. Wenatchee
Total		1,181,653		

1/ Kokanee; marked

2/ 25,598 marked

3/ Planted by the Oregon State Fish Commission

Table 6.--Hatchery releases of bluebacks, 1947

Date released	Hatchery	Number	Brood year	Released into--
Mar. 13	Winthrop	40,500	1945	Methow River
Mar. 14	Winthrop	2,000	1945	Methow River
Mar. 18	Winthrop	37,312	1945	Methow River
Apr. 8-9	Winthrop	337,590	1946	L. Osoyoos
Apr. 28	Leavenworth	220,776	1946	L. Wenatchee
June 23	Little White	23,833	1946	Drano Lake
June 24	Leavenworth	145,000	1946	L. Wenatchee
June 25	Leavenworth	124,650	1946	L. Wenatchee
Sept. 26	Leavenworth	76,619	1946	L. Wenatchee
Sept. 29	Leavenworth	110,984	1946	L. Wenatchee
Sept. 30	Leavenworth	85,001	1946	L. Wenatchee
Oct. 1-7	Leavenworth	894,327	1946	L. Wenatchee
Total		2,098,502		

Table 7.--Hatchery releases of bluebacks, 1948

Date released	Hatchery	Number	Brood year	Released into--
Mar. 10	Winthrop	97,000	1946	Methow River
May 4	Leavenworth	153,211	1947	White River 1/
May 5	Leavenworth	330,544	1947	White River 1/
May 29	Winthrop	310,397	1947	Methow River
June -	Leavenworth	10,111	1947	L. Wenatchee
June 23	Leavenworth	123,003	1947	L. Wenatchee
June 25	Leavenworth	267,223	1947	L. Wenatchee
July 2	Leavenworth	181,623	1947	L. Wenatchee
Aug. 18	Little White	131,257	1947	Drano Lake
Sept. 29	Leavenworth	634,694	1947	L. Wenatchee
Oct. -	Leavenworth	24,090	1947	L. Wenatchee
Oct. 1	Leavenworth	614,294	1947	L. Wenatchee
Oct. 6	Winthrop	24,286 2/	1947	Methow River
Oct. -	Metolius	19,992	1947	Blue Lake 3/
Oct. -	Metolius	21,168	1947	Suttle Lake 3/
Total		2,942,893		

1/ Tributary of Wenatchee
2/ Marked
3/ Tributaries of the Deschutes River, Oregon. Planted by the Oregon State Fish Commission

Table 8.--Hatchery releases of bluebacks, 1949

Date released	Hatchery	Number	Brood Year	Released into
Mar. 14	Winthrop	2,390 1/	1947	Methow River
May -	Leavenworth	1,755,786	1948	L. Wenatchee
July 22-28	Carson	415,772	1948	Drano Lake
Sept. 15	Winthrop	25,000 1/	1948	Methow River
Sept. 15-27	Winthrop	524,000	1948	L. Osoyoos
Sept. 29-Oct. 12	Leavenworth	3,060,512	1948	L. Wenatchee
Oct. 3	Entiat	9,930	1948	L. Wenatchee
Total		5,793,790		

1/ Marked

Table 9.--Hatchery releases of bluebacks and kokanee, 1950

Date released	Hatchery	Number	Brood Year	Released into
Mar. -	Metolius	99,922	1948	Metolius River 1/
Mar. 27	Winthrop	28,647 2/	1948	Methow River
Sept. & Oct.	Leavenworth	1,400,971	1949	L. Wenatchee
Oct. 5-6	Leavenworth	520,599 3/	1949	L. Wenatchee
Total		2,050,139		

1/ Tributary of the Deschutes River, Oregon. Planted by the Oregon State Fish Commission.

2/ 7,240 marked.

3/ Kokanee

Table 10.--Hatchery releases of blueback and kokanee, 1951

Date Released	Hatchery	Number	Brood Year	Released into
Feb. 5-6	Metolius	75,960 1/	1949	Metolius River
Mar. 9	Little White	4,043	1949	Drano Lake
Mar. 15	Winthrop	2,475 2/	1949	Methow River
Mar. 15	Winthrop	59,413	1950	Methow River
Apr. 18	Winthrop	25,006 3/	1950	Methow River
Sept. -	Entiat	27,775	1950	L. Wenatchee
Sept. 27	Leavenworth	181,610	1950	L. Wenatchee
Oct. 1-4	Leavenworth	485,000	1950	White River
Oct. 5	Leavenworth	594,300	1950	L. Wenatchee
Oct. 9	Leavenworth	477,476 2/	1950	White River
Total		1,933,058		

1/ Planted by the Oregon State Fish Commission.
2/ Kokanee
3/ Marked

Table 11.--Hatchery releases of blueback and kokanee, 1952

Date Released	Hatchery	Number	Brood Year	Released into
Feb. 13	Metolius	28,500 1/	1950	Metolius River
Feb. 13	Metolius	55,200 2/	1950	Suttle Lake
Feb. 25	Winthrop	1,163	1950	Methow River
Sept. -	Entiat	38,268	1951	L. Wenatchee
Oct. 8	Metolius	101,800 1/	1951	Suttle Lake
Oct. 10	Winthrop	12,000	1951	Methow River
Oct. 15	Leavenworth	90,302 3/	1951	L. Wenatchee
Nov. 13	Leavenworth	28,781 3/	1951	Wenatchee River 4/
Total		356,014		

1/ Planted by the Oregon State Fish Commission.
2/ Kokanee; planted by the Oregon State Fish Commission.
3/ Marked.
4/ Outlet of Wenatchee.

Table 12.--Hatchery releases of bluebacks, 1953

Date released	Hatchery	Number	Brood year	Released into --
Feb. 9 - Mar. 13	Klickitat	10, 791 1/	1951	Klickitat River
Feb. -	Little White	2, 625	1951	Drano Lake
Mar. 24	Winthrop	32, 692 2/	1951	Methow River
May 15-18	Little White	150, 900	1952	Drano Lake
May -	Little White	185, 344	1952	Lake Wenatchee
June -	Winthrop	79, 040	1952	Columbia River
June -	Winthrop	440, 960	1952	Lake Wenatchee
July 15	Metolius	55, 620 3/	1952	Suttle Lake
July -	Little White	9, 083	1952	Drano Lake
Sept. -	Leavenworth	192, 402	1952	Lake Wenatchee
Sept. -	Entiat	17, 902	1952	Lake Wenatchee
Oct. -	Leavenworth	62, 618	1952	Lake Wenatchee
Oct. 28	Metolius	142, 540 3/	1952	Suttle Lake
Nov. -	Leavenworth	148, 288	1952	Lake Wenatchee
Total		1,530, 805		

1/ Planted by the Washington State Department of Fisheries.

2/ Marked.

3/ Planted by the Oregon State Fish Commission.

caught at Bonneville from 231, 134 marked 2's released by Leavenworth hatchery in October and November (202, 353 were released into Lake Wenatchee and 28, 781 were released into the Wenatchee River). Eleven marked bluebacks were caught from 29, 189 2's released by Leavenworth hatchery in March into Icicle Creek. A total of 107 bluebacks were caught at Bonneville from an October release of 25, 351 marked bluebacks released by Little White hatchery into Drano Lake; 72 were caught from a March release of 25, 598 into Drano Lake. Table 13 shows hatchery releases of marked blueback salmon and numbers captured at Bonneville.

One reason for the greater apparent survival of spring releases from Leavenworth and Winthrop may be that the spring releases were composed of larger fish that spent less free time in fresh water. This would not explain why more fall fish were caught from a Little White release, because the above statement also applies to them. Perhaps the distance from the point of release to Bonneville was responsible for at least a part of the apparent difference in catches of fish from Little White and from Leavenworth and Winthrop.

Some of the fall marked bluebacks were released into rivers which could have caused a higher mortality. Fall releases are usually into lakes, where the fish spend the winter. Comparison of fall releases of marked 2's from Leavenworth into Lake Wenatchee in 1945 and from Winthrop into the Methow River in 1948 and 1949 shows very little difference in captures at Bonneville of these groups. Both the spring and fall releases from Little White hatchery were into Drano Lake, a part of the Little White Salmon River.

Marked bluebacks released in March from Leavenworth and Winthrop hatcheries appear at Bonneville before the catch of that species has peaked. The river flow is less in March than it is at the time of peak migration. Also, since the spring marked bluebacks were released into rivers, these fish would not be distributed in the same manner as the rest of the population. Therefore, if the proportion of marked fish in the total number migrating past Bonneville is greater early in the spring, and, as hypothesized on page 17, if the fingerling traps catch a higher percentage of the downstream migrants early in the spring, then marked bluebacks released at that time would be proportionally more numerous in the catches than bluebacks that migrated during the peak migration period later in the spring.

The 119, 083 bluebacks marked A+LV, released by Leavenworth hatchery in the fall of 1952, consisted of fish that had survived a virus disease which had caused serious mortality in the hatcheries. This factor could have affected the subsequent survival of this group of fish.

Lengths of Marked Migrants

Marked bluebacks are the only blueback migrants caught at Bonneville that are definitely known to be from the hatcheries. Only one fall release (planted in October and November 1952) is available for comparison. The sample sent by Leavenworth hatchery was from the November release and it ranged in length from 90 to 112 mm. (mean 98 mm.). A single 112-mm. specimen from these releases was measured at Bonneville (a second was caught but it was not measured). There were three spring releases that can be compared. The first was a release from Winthrop on March 27, 1950. The sample sent by the hatchery ranged in length from 113 to 138 mm. (mean 126 mm.). There were 11 recaptures at Bonneville, all within 19 days after the date of release, which ranged from 122 to 160 mm. (mean 139 mm.). The fingerling-trap catches averaged 13 mm. longer than the sample sent by the hatchery. On April 18, 1951, 25, 000 1's, marked adipose, were released from Winthrop. The sample sent by the hatchery ranged from 34 to 59 mm. (mean 45 mm.). Within 8 days 3 fish from this release were caught at Bonneville. Their lengths ranged from 62 to 71 mm. (mean 66 mm.), or an average of 21 mm. longer than the hatchery sample. A fourth fish from this release was captured on September 11, 1953, and it measured 197 mm. On March 25, 1953, 32, 692 2's, marked adipose and right ventral, were released by the Winthrop station. The hatchery sample ranged from 115 to 148 mm. (mean 131 mm.). Within 39 days 15 of these fish were caught at Bonneville; their lengths ranged from 138 to 193 mm.

Table 13.--Hatchery releases from 1945 to 1953 of marked blueback and kokanee salmon, with numbers recaptured at Bonneville Dam and their rate of migration.

Date released	Station	Mark	Brood year	Number released	Number caught	Days to reach dam			Distance travelled (miles)
						Min.	Max.	Mean	
Oct. 15, 1945	Little White	D+BV	1944	25, 351	107	53	172	90	20
Nov. 7, 1945	Leavenworth	An+LV	1944	26, 304	1	152	152	152	350
Nov. 7, 1945	Leavenworth	An+RV	1944	25, 619	0				
Nov. 9-15, 1945	Leavenworth	D+LV	1944	60, 128 1/	0				
Mar. 12, 1946	Leavenworth	D+RV	1944	29, 189 1/	11	22	58	28	350
Mar. 19, 1946	Little White	A+D	1944	25, 598	72	3	63	12	20
Oct. 6, 1948	Winthrop	RV	1947	24, 286	0				
Mar. 14, 1949	Winthrop	LV	1947	2, 390	1	21	21	21	420
Sept. 15, 1949	Winthrop	A	1948	25, 000	0				
Mar. 27, 1950	Winthrop	D	1948	7, 240	11	14	19	16	420
Apr. 18, 1951	Winthrop	A	1950	25, 006	4	8	877	228	420
Oct. 15, 1952	Leavenworth	A+LV	1951	90, 302)	2	177	177	177	350
Nov. 13, 1952	Leavenworth	A+LV	1951	28, 781)					
Mar. 24, 1953	Winthrop	A+RV	1951	32, 692	15	10	39	27	420

1/ Kokanee.

(mean 154 mm.). The bypass-trap sample averaged 23 mm. longer than the hatchery sample. The 193-mm. blueback from the above release had scale markings that made it appear a 3. The loss of the combination of fins listed above could have been accidental, but the evidence seemed conclusive enough to include this fish with the 2's, in spite of the age indicated by scale study.

In every case the average lengths of the marked bluebacks caught at Bonneville were greater than the samples sent by the hatcheries, even though the hatchery samples extended over a wide range of lengths and two age groups. Unfortunately, no data are available that can be compared with the Bonneville catches to test the traps for selectivity. However, the fingerling traps catch all sizes of migrants, and there is no evidence that they are size selective. Possibly the samples selected by the hatcheries were biased, and were of a smaller size than the mean size of the releases. The fish released in the spring may have added the growth necessary to compensate for the differences in length between the time of release and the time of recapture at Bonneville. Another possibility is that the larger fish of the releases had a better survival rate than the smaller fish.

The separation of the hatchery and wild fish by inspection of length-frequency graphs of the trap catches is not possible at this time. More data on lengths and abundance of the populations in Lakes Osoyoos and Wenatchee and of the hatchery fish would be necessary. Few hatchery fish were released in the fall of 1952. The catches in 1953 showed that those fish measuring from 115 to 130 mm. were much scarcer than in other years. This length group may be composed of fall-released hatchery fish. More fall releases of marked bluebacks into Lakes Osoyoos and Wenatchee would be helpful in separating hatchery fish from the wild fish caught at Bonneville Dam.

SUMMARY AND CONCLUSIONS

1. Ages of blueback downstream migrants caught at Bonneville Dam ranged from 1 to 5 years; 93 percent were 2-year-olds or in their second year.

2. The Bonneville catches indicate that the bulk of downstream-migrant bluebacks pass the dam in April and May.

3. The lengths of migrants of each age overlap; thus estimation of age from length is not possible for all fish.

4. Length-frequency graphs show no consistent separation of the races of Columbia River bluebacks at the time they pass Bonneville.

5. More marked bluebacks were caught at Bonneville from spring than from fall releases from Leavenworth and Winthrop hatcheries. The reverse was true of a spring and fall release from Little White hatchery.

6. The rate of travel of marked bluebacks varied. The fastest migrated 400 miles in 8 days. The slowest, from the same hatchery release, took 877 days to reach Bonneville. Limited data indicate that fish released in the spring migrate immediately, whereas those released in the fall do not migrate until the following spring. There is some evidence that fall releases from Little White reach Bonneville sooner than fall releases from Leavenworth and Winthrop.

7. The Bonneville catches are not usable to forecast abundance of returning adults without additional data.

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Appendix Table 1.--Numbers of bluebacks of each age caught in the fingerling-bypass traps at Bonneville Dam during the weekly periods in 1949.

Week ending	Week number	Age 1	2	3	4	5	Total
Jan. 7	1						
14	2						
21	3						
28	4						
Feb. 4	5						
11	6						
18	7						
25	8			1			1
Mar. 4	9		1				1
11	10						
18	11						
25	12						
Apr. 1	13		1				1
8	14		5				5
15	15		5	4			9
22	16		103	2			105
29	17		1078	112			1190
May 6	18		716	56			772
13	19		278	16			294
20	20		101	7			108
27	21		9				9
June 3	22		1	1			2
10	23						
17	24		1				1
24	25	3	1				4
July 1	26	12					12
8	27	7	1				8
15	28	1					1
22	29	1					1
29	30	3					3
Aug. 5	31	24					24
12	32	4					4
19	33	1	15				16
26	34	1	15				16
Sept. 2	35	1	2	1			4
9	36		1				1
16	37						
23	38						
30	39						
Oct. 7	40						
14	41						
21	42		1				1
28	43						
Nov. 4	44						
11	45						
18	46						
25	47						
Dec. 2	48						
9	49						
16	50	1					1
23	51						
31	52						
Total:		59	2335	200	0	0	2594

Appendix Table 2.--Numbers of bluebacks of each age caught in the fingerling-bypass traps at Bonneville Dam during the weekly periods in 1950.

Week ending	Week number	Age 1	2	3	4	5	Total
Jan. 7	1						
14	2						
21	3						
28	4		2				2
Feb. 4	5						
11	6						
18	7		3	1			4
25	8		4	5			9
Mar. 4	9		4	2			6
11	10			1			1
18	11		1				1
25	12		33	6			39
Apr. 1	13		47	4			51
8	14		54	1			55
15	15		37				37
22	16		12	9			21
29	17		8	2			10
May 6	18		36	10	1		47
13	19		221	3			224
20	20		272	8			280
27	21		123	4			127
June 3	22		67	4			71
10	23		12				12
17	24		11				11
24	25		1				1
July 1	26		1				1
8	27		1				1
15	28						
22	29						
29	30						
Aug. 5	31						
12	32						
19	33		2				2
26	34						
Sept. 2	35						
9	36						
16	37			1			1
23	38			1			1
30	39		2	1			3
Oct. 7	40						
14	41		1				1
21	42						
28	43						
Nov. 4	44						
11	45						
18	46						
25	47						
Dec. 2	48						
9	49		1				1
16	50						
23	51						
31	52						
Total		0	956	63	1	0	1020

Appendix Table 3.--Numbers of bluebacks of each age caught in the fingerling-bypass traps at Bonneville Dam during weekly periods in 1951.

Week ending	Week number	Age 1	2	3	4	5	Total
Jan. 7	1						
14	2						
21	3						
28	4						
Feb. 4	5						
11	6		9				9
18	7		24	2			26
25	8		6				6
Mar. 4	9		1				1
11	10		4	1			5
18	11		23				23
25	12		52	4			56
Apr. 1	13		60				60
8	14		78	1			79
15	15		60	1			61
22	16		50	5			55
29	17	1	47	2			50
May 6	18	2	518	15	5		540
13	19	3	263	6			272
20	20		51	1			52
27	21		20	1			21
June 3	22						
10	23		3				3
17	24			1			1
24	25		2	1			3
July 1	26		2				2
8	27	1					1
15	28	1					1
22	29		1				1
29	30						
Aug. 5	31						
12	32		1	1			2
19	33	1					1
26	34						
Sept. 2	35		2				2
9	36						
16	37		1				1
23	38	1					1
30	39						
Oct. 7	40			3			3
14	41		3	1			4
21	42	1					1
28	43						
Nov. 4	44						
11	45						
18	46	1					1
25	47						
Dec. 2	48						
9	49						
16	50						
23	51						
31	52						
Total		12	1281	46	5	0	1344

Appendix Table 4.--Numbers of bluebacks of each age caught in the fingerling-bypass traps at Bonneville Dam during weekly periods in 1952.

Week ending	Week number	Age 1	2	3	4	5	Total
Jan. 7	1						
14	2		1				1
21	3			1			1
28	4		2				2
Feb. 4	5						
11	6			1			1
18	7		10				10
25	8		20				20
Mar. 4	9		6				6
11	10		7	1			8
18	11		12				12
25	12		9				9
Apr. 1	13		12			1	13
8	14		6	6			12
15	15		9	3			12
22	16		177	3			180
29	17		338	2			340
May 6	18		285	23			308
13	19		520	25			545
20	20		154	1			155
27	21		33				33
June 3	22		9				9
10	23						
17	24	1					1
24	25	1	1				2
July 1	26	2	1				3
8	27	12					12
15	28	3					3
22	29	2					2
29	30						
Aug. 5	31						
12	32						
19	33		1				1
26	34		2				2
Sep. 2	35						
9	36						
16	37						
23	38						
30	39						
Oct. 7	40		1				1
14	41						
21	42						
28	43						
Nov. 4	44						
11	45						
18	46						
25	47						
Dec. 2	48						
9	49						
16	50						
23	51						
31	52						
Total		21	1616	66	0	1	1704

Appendix Table 5.--Numbers of bluebacks of each age caught in the fingerling-bypass traps at Bonneville Dam during weekly periods in 1953.

Week ending	Week number	Age 1	2	3	4	5	Total
Jan. 7	1						
14	2		7				7
21	3		4				4
28	4		3				3
Feb. 4	5						
11	6						
18	7						
25	8						
Mar. 4	9		6				6
11	10		3				3
18	11		3				3
25	12						
Apr. 1	13		7				7
8	14		5				5
15	15		2	1			3
22	16		8				8
29	17		20	1			21
May 6	18		364				364
13	19		553	3			556
20	20		153	1			154
27	21	2	164	18			184
June 3	22	1	64	6	3		74
10	23		10				10
17	24	1	8				9
24	25	9					9
July 1	26	1					1
8	27	8	1				9
15	28	2					2
22	29	6	1				7
29	30	3					3
Aug. 5	31						
12	32	2					2
19	33						
26	34						
Sept. 2	35	1					1
9	36		1				1
16	37		4	1			5
23	38		6	1			7
30	39			1			1
Oct. 7	40		10	1			11
14	41						
21	42		2				2
28	43						
Nov. 4	44		1				1
11	45						
18	46						
25	47						
Dec. 2	48						
9	49						
16	50						
23	51	1					1
31	52						
Total		37	1410	34	3	0	1484

Appendix Table 6.--Numbers of bluebacks of each age in 10 mm. size groups caught in the fingerling-bypass traps at Bonneville Dam in 1949.

Length	Age					Total
	1	2	3	4	5	
31-40	2					2
41-50	15					15
51-60	12					12
61-70	8	18				26
71-80	16	149				165
81-90	5	307				312
91-100		296				296
101-110		835				835
111-120	1	421				422
121-130		109				109
131-140		35				35
141-150		54				54
151-160		40				40
161-170		26	2			28
171-180		17				17
181-190		8	24			32
191-200		18	5			23
201-120		1	11			12
211-220		1	9			10
221-230			9			9
231-240			74			74
241-250			22			22
251-260			36			36
261-270						
271-280			8			8
Total	59	2335	200	0	0	2594

Appendix Table 7.--Numbers of bluebacks of each age in 10 mm. size groups caught in the fingerling-bypass traps at Bonneville Dam in 1950.

Length	Age					Total
	1	2	3	4	5	
31-40						
41-50						
51-60						
61-70						
71-80		28				28
81-90		85				85
91-100		322				322
101-110		275				275
111-120		118				118
121-130		56				56
131-140		36				36
141-150		17				17
151-160		13				13
161-170		2	1			3
171-180			4			4
181-190			6			6
191-200		1	3			4
201-210		1	1			2
211-220			11			11
221-230			8			8
231-240		2	6			8
241-250			12			12
251-260			7			7
261-270			1			1
271-280			1			1
281-290						
291-300			1			1
301-310			1			1
311-320						
321-330						
331-340						
341-350				1		1
"						
Total	0	956	63	1	0	1020

Appendix Table 8.--Numbers of bluebacks of each age in 10 mm. size groups caught in the fingerling-bypass traps at Bonneville Dam in 1951.

Length	Age					Total
	1	2	3	4	5	
31-40						
41-50						
51-60						
61-70	5					5
71-80	3	14				17
81-90	1	37				38
91-100	2	176				178
101-110	1	371				372
111-120		318				318
121-130		138				138
131-140		94				94
141-150		76	1			77
151-160		26				26
161-170		17				17
171-180		8	2			10
181-190		1				1
191-200		3	4			7
201-210		1	8			9
211-220		1	13			14
221-230			8			8
231-240			4			4
241-250			1			1
251-260			2			2
261-270			3			3
271-280						
281-290						
291-300						
301-310				5		5
Total	12	1281	46	5	0	1344

Appendix Table 9.--Numbers of bluebacks of each age in 10 mm. size groups caught in the fingerling-bypass traps at Bonneville Dam in 1952.

Length	Age					Total
	1	2	3	4	5	
31-40						
41-50						
51-60						
61-70	5					5
71-80	13	5				18
81-90	3	37				40
91-100		289				289
101-110		557				558
111-120		458				458
121-130		123				123
131-140		59				59
141-150		48				48
151-160		22				22
161-170		10				10
171-180		5	4			9
191-190						
191-200			6			6
201-210			5			5
211-220		3	5			8
221-230			23			23
231-240			14			14
241-250			2			2
251-260			7			7
261-270						
271-280						
281-290					1	1
Total	21	1615	66	0	1	1704

Appendix Table 10.--Numbers of bluebacks of each age in 10 mm. size groups caught in the fingerling-bypass traps at Bonneville Dam in 1953.

Length	Age					Total
	1	2	3	4	5	
31-40						
41-50						
51-60	3					3
61-70	2	4				6
71-80	10	1				11
81-90	13	101				114
91-100	6	478				485
101-110	3	519				522
111-120		92				92
121-130		17				17
131-140		74				74
141-150		48				48
151-160		36				36
161-170		9	2			11
171-180		15	5			20
181-190		4	1			5
191-200		9	2			11
201-210		2				2
211-220						
221-230			3			3
231-240						
241-250		1	6			7
251-260			6			6
261-270			2			2
271-280			6	2		8
281-290			1			1
291-300				1		1
Total	37	1410	34	3	0	1484

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